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Letters from the United States of North America on Internal Improvements, Steam Navigation, Banking, &c., written by FRANCIS ANTHONY CHEVALIER DE GERSTNER, *during his sojourn in the United States, in* 1839.

(Translated from the German, by L. KLEIN, Civil Engineer.)

LETTER III.

Wilmington, North Carolina, March 31*st*, 1839.

Post Office Department, Transportation of the Mail in Steamboats and upon Railroads.

The Post Office department forms in the United States an important branch of the administration of the General Government; the principle has been adopted that the surplus of receipts over the expenditure shall be applied to the establishment of new post roads; the General Government derives, therefore, no increase of revenue from this branch of the public service. The whole Post Office department is superintended by a Postmaster General, who is a member of the Cabinet of the President of the United States: but, like the other cabinet officers, receives only the moderate salary of 6000 dollars.

The Postmaster General appoints all the Deputy Postmasters and their assistants, throughout the Union; and dismisses them at his discretion. The Postmasters have no fixed salaries, but receive a per centage of the income to an amount not to exceed 2000 dollars a year. The transportation of the

mail is let by contract to stage proprietors, or to railroad and steamboat companies; on less frequented roads the mail is carried on horseback or in sulkies, also by contract. The transportation of passengers, of small packages, and other objects, except the mail, is left to private enterprise, and privileged postholders no where exist. The length of the postroads in 1838, was, according to the Postmaster General's report, 134,818 miles; the number of post offices, 12,519, and the number of miles the mail has been carried in the last three years, were as follows:

Transportation of the Mail.

Year.	Upon common roads.	On horseback and in sulkies.	Upon railroads and in steamboats.	Total number of miles.
1836	17,408,820	8,291,504	1,878,296	27,578,620
1837	18,804,700	11,999,282	1,793,024	32,597,006
1838	20,593,192	11,573,918	2,413,092	34,580,202

In the year 1838 the transportation of the mail was let to 1947 individuals or companies, and the expenses have been:

Year 1838.	The mail was transported.	Expenses of transportation.	Expenses per mile of single transportation.
	Miles.	Dollars.	Cents.
Upon common roads, . .	20,593,192	1,889,792	$9\frac{1}{6}$
On horseback and in sulkies, . .	11,573,918	831,028	$7\frac{1}{8}$
Upon railroads and in steamboats,	2,413,092	410,488	17
Total, ...	34,580,202	3,131,308	11

These statements serve to show the immense extent of the post arrangements in this country, and the increase in the transportation of the mail upon railroads and in steamboats. In 1832 the mail was carried 499,301 miles upon railroads and in steamboats; 6 years later the number of miles had increased to 2,413,092, or five-fold.

The Government considers railroads as private property, and each contract for the transportation of the mail upon them is therefore made with the free consent and agreement of both parties. Congress had up to this time only determined that the maximum compensation allowed to railroad companies should not exceed 25 per cent. over that allowed on common roads, upon which the mail is carried so much slower. The transportation of the great Western mail, between Baltimore and Cincinnati, costs annually 190 dollars per mile of road, for which sum the contractor has to carry the mail daily once in each direction. The addition of 25 per cent. gives $237\frac{1}{2}$ dollars as the amount, which is paid to most of the railroad companies; this is equal to $32\frac{1}{2}$ cents for the transportation of the mail a single time one mile; an amount which might be reduced to one-half in Germany, in consequence of the prices of all articles being there smaller in the same proportion. The railroad companies here were dissatisfied with the above compensation, and declared their unwillingness to transport the mail any longer for the same; Congress, in its present session, has, therefore, authorised the Postmaster General to increase the compensation to 300 dollars per mile per

year; this gives for a single transportation of the mail, one mile, 41 cents. It is to be remarked, however, that upon railroads the great mails are principally carried weighing from 2000 to 3000 pounds, while with stages the mails are generally smaller. The high price allowed to the railroad companies shows sufficiently that it is regarded here as highly important to have the mail carried upon railroads in preference to other conveyances.

The railroad companies are on their part bound to keep the time prescribed by the Postmaster General, and they lose the compensation for a whole day if the mail arrives once later than at the specified hour.

Management of Railroads in Winter.

The majority of the American railroads are located in the northern States, where in winter the canals are frozen during four months, and the snow often falls several feet deep. As the railroads frequently pass through deep cuts, the difficulties occasioned by the snow are much increased. After many experiments, a proper apparatus has been invented, which has been found to answer very well. This machine clears the snow, and breaks and clears the ice off the rails. If the snow lays only a few inches deep, the apparatus is attached to the locomotive, and the train starts at the usual hour; but when the snow is deeper, a separate engine is despatched with the apparatus, in advance of the train, to clear the track. Parts of the Utica and Schenectady Railroad were covered with snow last winter, from three to four feet in depth; two, and once three, engines were sent from the depot, which, being connected together, moved the apparatus before them, and cleared the track. In this way they succeeded in overcoming the obstacle entirely, and in making the trips regularly and in the usual time.

Precaution is also necessary with the *locomotive engine*, to prevent the pumps and pipes from freezing, and to protect the engineman and fireman from the frost. The engine is therefore put under cover, and engineer and fireman stand under a tent of canvas, which covers part of the engine and tender. Two windows in front allow the engineer to overlook the road and engine, while the access of the cold air is almost entirely prevented, and men and engine are safe from frost and snow. The passengers are transported in long eight-wheeled cars, containing each from fifty to sixty seats, and a stove, to heat the car comfortably. On each end of the car is a platform, over which it is easy to get from one car to the other during the journey, and to visit one's friends and acquaintances. Some cars contain a bar with refreshments; others have separate apartments for ladies, in which they are attended by female servants; finally, they have gone so far as to construct a car with forty-two beds, that the passengers may quietly sleep during their night journey, which beds are transformed into seats in the day time. A railroad car here, resembles, therefore, a steamboat; on board of it, (as the Americans say,) one may have all the comforts of the latter, and accomplish an agreeable journey, without being subject to sea-sickness.

The longest Railroad connection in the United States.

In my second letter I took occasion to make mention of the most expensive railroad in this country. I shall now speak of the longest railroad connection, in order to show that the American railroads are not short, not without connection with each other, and not constructed for pleasure travelling only, but that they are regarded as great thoroughfares, as connecting the most distant points of the Union, and are principally used by business men.

The railroad which may be regarded as the longest in the world, extends from Boston, in Massachusetts, to Greensboro', in Georgia, and is composed of the following sections:

From.	To.	Communication.	Distance in miles.	Weight of rails.	No. of locomotives.	Cost of construction. Whole road.	Cost of construction. Per mile.
						Dollars.	Dollars.
Boston	Providence	railroad	42	55 lbs.	11	1,600,000	38,095
Providence	Stonington	do.	47½	58 "	6	2,500,000	52,632
Stonington	New York	steamboat	130				
New York	New Brunswick	railroad	31	38 "	7	1,752,200	56,522
N. Brunswick	Trenton	do.	27½	41 "	4	497,800	18,102
Trenton	Philadelphia	do.	30	13 "	4	400,000	13,333
Philadelphia	Wilmington, Del.	do.	28			500,000	17,857
Wilmington	Havre deGrace	do.	35	35 "	14	800,000	22,857
Havre deGrace	Baltimore	do.	36	40 "		950,000	36,390
Baltimore	Washington	do.	39	40 "	4	2,040,330	52,316
Washington	Aquia Creek	steamboat	60				
Aquia Creek	Fredericksburg	stage	13				
Fredericksburg	Richmond	railroad	61½	10½ "	12	1,200,000	19,512
Richmond	Petersburg	do.	22½	9½ "	5	700,000	31,111
Petersburg	Weldon	do.	60	9½ "	12	766,267	12,771
Weldon	Wilmington, N.C	do.	160	12 "	10	1,360,000	8,500
Wilmington	Charleston	steamboat	160				
Charleston	Augusta	railroad	136	25½ "	27	2,000,000	14,706
Augusta	Greensboro'	do.	84	17 "	10	1,176,000	14,000
			1203				

NOTE. Between Aquia Creek and Fredericksburg, the railroad will be constructed in 1839; between Weldon and Wilmington, (N. C.) there are now only 103 miles of railroad in operation; the remainder of the distance is under construction, and will likely be completed in 1839.

On this line of 1203 miles in length, therefore, 853 miles are traveled upon railroads, and 350 miles in steamboats. The whole distance is performed in five days, or 120 hours, or at an average ten miles per hour.—This includes all stoppages for meals, and besides, ten hours in New York. As soon as the above mentioned two sections of railroads are completed, the passage may be performed in 100 hours, or 12 miles per hour, including stoppages. This is a considerable speed for such a long voyage, on which five nights are spent, and if the railroads did not belong to thirteen different companies, whereby much time is wasted in passing the baggage from one train to another, a speed of fifteen miles per hour, including stoppages, could be attained.

The Americans, however, are not satisfied with the above railroad and steamboat connection of 1203 miles, and are establishing an opposition line between Stonington and Weldon, consisting of the following parts:

From.	To.	Communication.	Distance	Weight of rails. per yard.	No. locomotives.	Cost of Railroad. Total.	Cost of Railroad. Per mile.
			Miles.			Dollars.	Dollars.
Stonington	Greenport	steamboat	25				
Greenport	New York	railroad	94	21 lbs.	10	2,033,850	21,636
New York	Amboy	steamboat	25				
Amboy	Philadelphia	railroad	61	41 "	12	2,101,500	34,450
Philadelphia	Elkton	do.	44			885,712	19,675
Elkton	Somersetcove	do.	118	9½ "	8	1,024,378	8,681
Somersetcove	Portsmouth	steamboat	85				
Portsmouth	Weldon	railroad	78	9½ "	7	850,000	10,897

The railroad from Greenport to New York is not yet completed, therefore the steamboats now go direct to New York; the railroad from Elkton to Somersetcove is also yet under construction.

If this line be compared with the above described between Stonington and Weldon, it appears that the first consists in 383½ miles of railroads and 198 miles of steam navigation, and the second in 395 miles of railroads and 135 miles of steam navigation.

The above described line of railroad and steamboat communication of 1283 miles in length, is now being continued at both ends. From Boston to Portland, in Maine, a railroad of 100 miles in length is under construction, and will be completed in the course of two years. From Greensboro' to Montgomery, in Alabama, 210 miles, a railroad is also under construction and may be completed in the course of three years. From Montgomery, steamboats go upon the Alabama river to Mobile, and others from there to New Orleans. In the course of three years, therefore, the journey from Portland to New Orleans will be made in eight days, while six years ago the journey by land took forty days. The steam navigation along the sea coast has been nearly given up, in consequence of the dangerous navigation round the Capes. New Orleans is situated 13⅔ degrees south, and 19⅔ degrees west, of Portland, and the distance in a straight line is over 1400 miles. The whole line of communication will consist of 1195 miles of railroads and 884 miles of steam navigation, making together 2080 miles, which is certainly the most gigantic internal communication of this kind in the whole world, and will remain so for a long time to come.

Length and Cost of Construction of all Railroads now in operation in the United States.

In the above described two lines of communication, the one from Boston to Greensboro', Georgia, and the other between Stonington and Weldon, are nineteen different railroads, constructed by as many different corporations. The total length of these railroads is 1,191 miles, and their cost 24,252,325 dollars; the cost per mile varies according to the evenness of the surface, the weight of the iron rails or bars, and the number of locomotive, cars, &c. used upon them. It is evident that the average cost of these railroads per mile, cannot be taken as a standard, from which to calculate the cost of new railroads in America or other countries; this average, which amounts here to 20,363 dollars, will serve however, to show what the Americans have already expended for railroads.

As the American Union is formed by twenty-six different independent States, I have, as yet, not been able to compose an accurate list of all the railroads now in operation in the United States. Having, however, within the last five months, traveled over more than 2,000 miles of railroads, and obtained information in regard to most of the others, I am enabled to state, with sufficient accuracy, the total length of all the railroads in operation: this length is 3,000 miles, and taking the average cost per mile, at 20,000 dollars, the total cost of their construction has been sixty millions of dollars. The railroads have been constructed by about 100 companies and several of the State Governments. The number of locomotive engines in use is 425, equal to one engine for seven miles of road.

Length of Railroads to be opened in the year 1839.

Some of the railroads now in operation will be continued, and others now

in progress of construction will be opened in part. The length of railroads which may be expected to be completed up to the end of 1839, I estimate at 1,100 miles. This length of railroads, completed by the Americans in one year, is equal to the distance from St. Petersburg through Moscow to Odessa, and far greater than the distance from the Russian frontier, near Memel, through Berlin and Leipzick, to the frontier of Holland, on the Rhine.

The capital, which at the end of 1839, will be expended for railroads, to the extent of 4,100 miles, will, at the rate of 20,000 dollars per mile, amount to 82,000,000 dollars. If to this be added, only 8,000,000 dollars for those railroads already in progress, but not in operation, at the end of 1839, we obtain, as the total sum expended for railroads alone, ninety millions of dollars. The construction of the American railroads may be regarded as having commenced only in 1830; the above large sum has, therefore, notwithstanding the commercial crisis of 1837 and 1838, been expended almost entirely within the last ten years, by a young country, the population of which was at the last census, in 1830, only 12,860,680, and will amount at present, to not more than sixteen millions. It is a known fact, that the extent of all railroads in the world, America excepted, is only 1,600 miles; the Americans may therefore justly be regarded as the only nation which perfectly understands that railroads are nothing else than "*very good roads*," and that by their introduction alone, the two greatest internal enemies of an extensive state, "space and time," can be vanquished with success.

Letter IV.

Augusta, Georgia, April 15, 1839.

Transportation of Passengers and Freight upon the American Railroads.

The passage money upon the line of railroads and steam navigation, described in my last letter, between Boston and Greensboro', amounts to sixty-six and one-fourth dollars for the distance of 1203 miles. After the completion of the two sections, upon which stages are now running, the price will be reduced to sixty dollars. This gives, at an average, five cents per mile. Upon the stage roads in America, the average fare per mile is six and one-fourth cents, and the speed is only four miles per hour, including stoppages. Upon the railroads, therefore, one-fifth of the cost and two-thirds of the time required on common roads, are saved.

The *freight* upon the American railroads consists in manufactured articles, in drugs, cotton, tobacco, and rice, in flour and grain, in coal, lumber, wood, hay, and other agricultural products. The charges for the transportation of merchandize is seven and one-half cents per ton of 2000 lbs., per mile. Heavy and cheap articles are transported at a lower rate.

Number of Passengers and Tonnage.

The American railroads are, as already mentioned, thoroughfares between the several States, and are used principally for business. During the summer, the number of passengers is increased in consequence of many families making pleasure tours, or visiting water places, &c. &c.; but on the whole, the difference between the number of passengers in summer and winter is less here than in Europe. The Americans are an active, enterprising people, and know how to appreciate the value of time, and as the

population, compared with the extent of the country, is so much smaller than in Europe, it is evident, *that the number of passengers on the American railroads must be much less than upon those in Europe.* According to the information I received of the operations of a great number of railroads, the average number of passengers, reduced to the whole length of the roads, is only 35,000 annually.

The transportation of merchandize and produce is carried on to a great extent along the sea-coast, or upon the great Lakes; much more, however, upon the large navigable rivers, with which Providence has so much blessed this country. I have already mentioned in my second letter, that there are now 800 steamboats employed in America, and I have only to add, that most of them are used upon the rivers, for the reason that along the sea-coast passengers prefer railroads to steamboats. The connection of the rivers is effected by canals, the extent of which was already, three years ago, according to the then published reports, 3300 miles, and has been considerably increased since that time. Upon these canals there is generally a very great traffic, and only a small portion of freight is left for railroad transportation. According to ascertained facts, there are now, annually, transported over the American railroads about 15,000 tons of freight.

I have to remark here, that these numbers represent the *present traffic* upon the railroads. But, like every other thing in America, this traffic is constantly increasing. There are railroads, on which the traffic and revenue increase 25 per cent. annually, and I believe I do not err, in calculating the *annual average increase* at ten per cent.

Gross Income, Current Expenses and Interest on the Capital of Construction.

According to the foregoing results, the annual gross income, per mile of road in America, is—

From 35,000 passengers at 5 cents. . .	$1,750
" 15,000 tons of freight at 7½ cents, . .	1,125
" transportation of mail, and incidentals, .	200
Total	$3,075

If this amount be compared with the average cost of the roads per mile, viz: 20,363 dollars, we see, that the yearly gross income is 15 per cent. on the capital invested.

The current expenses on the American railroads are proportionally small. If the total expenses of every kind be divided according to the number of passengers and tons of goods, conveyed over the road, the following average result is obtained on those railroads of which I received the accounts:

The transportation of a passenger one mile, costs 2½ cents, therefore, of 3,500 passengers,	$875
The transportation of one ton of goods one mile, costs 6½ cents, therefore of 15,000 tons,	975
The expenses accruing from the transportation of the mail, and incidentals, may be estimated at one half the income from these services,	100
Total	$1,950

These expenses deducted from the gross receipts of 3,075 dollars, leave 1,125 dollars as the yearly net proceeds per mile of railroad, which compared with the cost of one mile of road, 20,363 dollars, shows an annual interest of 5½ per cent. on the capital invested.

I remark here, that this is only an average result on *those railroads which I have already inspected,* and of which some yield 10 per cent. while others yield no dividend at all; my further inspection of the several railroads here will perhaps occasion some, although, I believe, only slight alterations in these numbers.

A profit of $5\frac{1}{2}$ per cent. would be far too little inducement for the Americans, who know so well how to invest their capital profitably; but most of the railroads here were undertaken by the owners of property, and merchants in the vicinity of the line; these, of course, take into consideration the profit arising to them by the increased facility of internal communication, and calculate, that as the intercourse is constantly growing, the profits from the road must necessarily also, from year to year, increase. Some of the railroads in the Southern and Western States were constructed at the expense of the government, and a large share of the capital was attained by loans negotiated principally in England. These are the reasons why so many railroads have already been constructed in America, and still more will be undertaken in years to come, until the immense surface of country, occupied by the United States, is covered with a net of railroads, by which all the principal points will be connected.

Causes of the Cheap Construction of American Railroads.

In my last letter I stated the cost of nineteen railroads, which varies from 8,500 dollars to 56,500 dollars per mile, but amounts at an average to 20,363 dollars; this sum comprises the expenses for the right of way, the construction of the road and buildings, the purchase of locomotive engines and cars, and engineering. Labour is much dearer in America than in Europe—a common workman gets here one dollar, a carpenter two dollars, a mason two and a half dollars, daily wages. Timber is at an average dearer here than on the Continent of Europe; the railroad iron is procured from England and imported free of duty, but for locomotive engines, wheels, axles, &c., the duty is 20 per cent. on their value. On the whole, it may be asserted that prices, so far as regards public works, are here twice as high as in Germany and Russia. In what then consists the secret of the cheap construction of American railroads? The solution of this question, together with the enquiry into the management of the American railroads, having been one of the objects which led me to this country, I believe I am able, after a careful examination during five months, to give the following satisfactory explanation of the matter:

1. The American railroads have frequently grades of thirty feet per mile, (or a rise of one in 176) and curves of 2000 feet radius, and they are nearly all undulating; a great part of the earth-work (excavations and embankments) and high bridges are thereby avoided. Inclined planes have been nearly abandoned, and tunnels are very seldom resorted to. If a high ridge is to be surmounted, grades rising to ninety feet per mile are adopted. On the railroad from Baltimore to York, a grade of eighty-three and a half feet per mile (or one in sixty-three) has been adopted for a distance of two miles; this grade is ascended by locomotives drawing four eight-wheeled cars, loaded with seven tons or 14,000 pounds each. On the Greensville and Roanoke Railroad is a rise of ninety-three and a half feet per mile (or one in fifty-six) on a distance of 9,100 feet, which is also daily ascended by locomotive engines. Where it is necessary, curves of as short a radius

as 600 feet are adopted, and no difficulty is experienced in using upon them the engines and cars of American construction.

2. Labour being very high in America, the use of machinery is more frequently resorted to. On the Utica and Syracuse Railroad, for instance, I saw in operation a steam pile-driving machine, by which the piles were lifted, a pair of them driven in at once, and then cut off at the suitable height; seven men were necessary for the management of the machine, and fifty-five piles were driven in a day to the necessary depth. On the railroad from Worcester to Springfield, now in progress, a steam excavating machine is employed, which excavates the earth and puts it upon railroad cars, while the machine moves itself forward. The work done by this machine is the excavation of 16,000 cubic feet of earth per day. Many other contrivances are frequently met with, which the space of this letter would not allow me to describe.

3. The United States are intersected by many and large rivers, and therefore a greater number of bridges are required on the American railroads than on the European. American genius has found a remedy also here. Bridges are constructed on a quite new and very cheap plan. On the railroad from Richmond to Petersburg, in Virginia, for example, a bridge was built over the James river, 2,859 feet in length, resting upon two stone abutments and eighteen stone piers; the greatest distance from centre to centre of piers is 160 feet, the superstructure is of wood and made of planks, twelve inches wide and three inches thick. The floor of the bridge it sixty feet above the surface of the water, and the whole structure cost 115,000 dollars.—The construction of this bridge was commenced in December, 1836, and it was opened on the 5th day of September, 1838. Bridges of this size are numerous in America, and are executed at an expense, which, compared with the price of materials and labour, must be regarded as very small.

4. The superstructure of the railroads in America is made conformable to the expected traffic, and costs therefore more or less accordingly. In the statement I gave in my third letter, some railroads appear with iron rails of 58 lbs. per yard, and others of only 9½ lbs. Many companies had not the means to purchase heavy rails; they therefore, at first, employed weak bars, and changed them afterwards for stronger ones, when the traffic on the road had increased. Upon the railroads with weak bars lighter engines are generally used.

5. The buildings on the American railroads are made strictly conformable to their necessities, and constructed with the greatest economy. The number of locomotive engines, of passenger and freight cars, is also much smaller here than on most of the European railroads with an equal traffic. Like the people themselves, the engines here are seen constantly in motion, and they seldom keep a reserve.

Considering the whole, it appears that the cheapness of tne American railroads has its foundation in the practical sense which predominates in their construction. If it is true, that the country is generally more favourable *here* for the location of railroads than in Germany, the cheapness of labour *there* would enable them to make railroads in Germany as cheap as here, if they were only influenced by the same practical spirit. In Russia, where the country is far more favourable, there can be no doubt, that long railroad lines, upon which no very great traffic is to be expected, may be established at the cost of from 16,000 to 20,000 dollars per mile, or from 12,000 to 15,000 silver rubles per werst.

Causes of the cheap Management of American Railroads.

The American railroads with the small traffic upon them, would doubtless not yield any profit whatever, if managed on the European costly style; it is therefore important to know also the causes of the small expenditure in their management. They are the following:

1. The *administration of all railroads* in America, without exception, is very different from, and simpler than, that in Europe. The board of directors of the company has unlimited power, fixes at its discretion the yearly dividends, and consults the stockholders only when the charter has to be amended, and applications for it are to be made to the legislature. There occurs, therefore, no intervention from the part of the stockholders, neither in their general meetings, nor at any other time; but the stockholders elect annually new directors; the latter have besides to make a yearly report to the stockholders, which is generally printed, and they are therefore subject to public opinion, which always expresses itself without reserve. The directors transfer generally the special direction of the work to an able individual, who, in such case, has the entire control over it. Their agent receives a salary of from 2,000 to 5,000 dollars per year, according to the magnitude and revenue of the work. Besides him is appointed a treasurer with a salary of 1,000 to 1,500 dollars, and sometimes also a clerk, with a salary of some hundred dollars. These individuals do, with their intelligence and activity, pretty near the same work, for which, in Europe, three times as many persons are generally employed. The same principle is followed with all other individuals necessary for the management of the road, they are all very well paid, but perform also much in proportion. It must, indeed, strike every foreigner, who passes over an American railroad, to see almost nobody on the line, so few persons at the stations, and nevertheless so much order and punctuality in the whole management.

2. The *speed upon most of the railroads* in America seldom exceeds fifteen miles per hour with passengers, and eight to twelve miles with merchandize. There are railroads upon which the passenger trains travel with a speed of twenty-five miles per hour, but these are exceptions. On the other hand the railroads pass through, or go to the centre of the cities and towns, by which the loss of time often occasioned in using omnibuses at the terminus of a road, is avoided. By diminishing the speed upon the railroads there is produced a very considerable, as yet not enough appreciated, reduction in the expenses of repairs of the road itself, the locomotives, and the cars. At a speed of from twenty-five to thirty miles per hour, engines and cars are, with the small width of track here, (usually of four feet eight and a half inches,) injured by every imperfection in the road, and they in turn destroy the track. This is the reason why the speed of fifteen miles per hour is seldom exceeded here, and the consequence of it is, that the total expenses of maintenance of way, comprising supervision, labour, and materials, are at an average only of 500 dollars per mile, annually, equal to the wages of one workman, with 200 dollars for materials.

3. The *locomotive engines* are constructed on a better plan here, than in England. The engine rests behind upon a pair of driving-wheels, and in front, upon a movable four-wheeled truck, which conforms easily to the curvature and unevenness of the road. Such an engine may therefore be regarded as a four-wheeled one, with one of the axles movable, while it actually rests upon six wheels, and therefore has all the advantages of a six-wheeled locomotive. Some of the locomotives have an outside connexion instead of a crank axle; and in constructing the engines, regard is generally

had to the grades and curvatures of the road, and whether they are to be used for passengers or freight. The weight of the engines is proportionate to the strength of the iron rails or bars, employed on the road. They have also commenced here to make eight-wheeled tenders, which can carry enough fuel and water to serve for a distance of forty to sixty miles, without it being necessary to stop the train. The pressure of the wheels upon the rails is less with these than with the four-wheeled tender, and they have at the same time the advantage of keeping better upon the track, and will not follow the engine when it leaves the rails. It will appear from these facts, that the locomotive and tender, which are so destructive to the road when constructed on the English plan, have here a much easier motion, and conform better to the curves and inequalities of the track.

4. The same qualities are found in the American *eight-wheeled passenger and freight cars.* Their advantages are so evident, that the four-wheeled cars are fast disappearing from the roads, and eight-wheeled cars substituting for them. These cars rest upon two trucks and have a very easy motion, even when the road is uneven, and not in the best order. It seldom occurs, that an eight-wheeled car leaves the track, which the four-wheeled cars are so apt to do, especially in sharp curves. When two trains happen to meet each other upon the same track, these cars are of course materially injured by the violent concussion, but almost never thrown off the track, broken to pieces, and passengers killed. It is owing to the eight-wheeled cars, that upon railroads with plate rails of two to two and a half inches in width and one-half to three-quarter inch in thickness, passengers may be carried at a speed of fifteen miles and more per hour, without feeling any unpleasant motion. The wear and tear of the track, as well as the cars, are thereby materially lessened, and the expenses for repairs of cars are, like those of locomotives, much less here than in Europe. As these repairs constitute a great item in the expenditures incident to the management of a railroad, it must be of great advantage to introduce the American cars and locomotives upon the European railroads. The price of an eight-wheeled passenger car, with fifty seats, varies from 1,800 to 2,400 dollars, according to the elegance and internal arrangements. An eight-wheeled freight car costs about 750 dollars.

The cost of a whole train, consisting of a snow apparatus, a locomotive engine with tender, and the necessary duplicates in four eight-wheeled passenger cars, and one four-wheeled freight or baggage car, is from 16,000 to 20,000 dollars, according to the size and weight of the engine, and the finish of the cars. In my opinion it would be of great advantage for every railroad company in Europe, to procure here at least, *one* such train; those companies however, whose works are yet under construction, I can advise with the fullest conviction, to procure all their locomotive engines and tenders from America, and construct their cars after the American model.

5. As *fuel* for locomotive engines, coal is seldom used in America. In Europe, the use of wood, as the cheaper fuel, has been tried, but abandoned again in consequence of the sparks coming out through the chimney and injuring and annoying the passengers. The same trials were made here, and a number of spark-catchers invented, some of which are found to answer their purpose so well, that, with some little attention only, wood can be employed as fuel; the latter is here, as in Europe, much cheaper than coal or coke.

6. A considerable reduction of expenditure in the management of Ameri-

can railroads results from the circumstance, that they are established so as to be adapted to the wants of the country. I have already mentioned the fact, that railroads are passed through populous streets of the largest cities, as of New York, Philadelphia, Baltimore, etc.; on the outskirts of these cities, the locomotive is separated from the train, and horses are attached; of which four generally draw an eight-wheeled car. Along the tracks in the streets stand the large warehouses, and side tracks, often from twenty to thirty in one street, lead into them. These sidings branch off the main track with curvatures of fifty to sixty feet radius, and by a peculiar construction, the cars are prevented from running off the track. By this arrangement the forwarding merchant receives his goods delivered into the very house, upon the railroad cars; passengers depart upon the railroads from the centre of the cities, and arrive in the same manner. The waste of time, the expensive transhipment of the goods, and the omnibuses for passengers, are thereby avoided, and the expenses incident to the management of the roads greatly reduced. The turning platforms, which in England are generally made of iron, are here made of wood, and large enough for engine and tender to be turned at once, by one or two men —their cost is at the same time much less. Many other arrangements are found on the American railroads, which facilitate the operations and reduce the current expenses.

The above exposition shows that it is entirely in the power of the railroad companies in Europe to reduce the expenses on their railroads in the same manner as they do in America.

Railroads with Flat Bars upon continuous Wooden Bearings.

From my third letter it may be inferred, that on a great part of the American railroads, plate rails from two to two and a half inches in width, and one-half to three-quarter inches in thickness, spiked on wood, are employed. The use of these flat bars, instead of heavy iron rails, contributes much to diminish the cost of construction of the American railroads, but in Europe, the opinion prevails, that these roads are subject to very heavy repairs, and are entirely destroyed after a few years, if locomotives are used upon them. As long as English locomotives, with fixed parallel axles, and four-wheeled cars, were used in America, a constant destruction of the road, and consequently of the locomotives and cars, actually took place; but the results have become quite different since the introduction upon these roads of eight-wheeled cars and six-wheeled locomotives, as formerly described. It is a remarkable fact, proved by the experience of several years, that the management of a railroad with plate rails of two and a half by five-eighth inches, and wooden superstructure, is not more expensive than the management of a railroad with massive bars, of from forty to fifty pounds per yard, provided that the speed upon the plate railroads be only twelve to fifteen miles, and upon the others twenty to twenty-five miles per hour. The increased speed upon the heavy rails so much augments the repairs of locomotives and cars, that the expenses of the latter counterbalance the great cost of maintenance and renewal of the plate rails. I came to this conclusion from extracts made from the accounts of several railroad companies, and am of opinion that well constructed and carefully managed railroads with flat bars, would in many cases answer every purpose in Germany and Russia. Should however the traffic of a railroad be so great, that trains have to pass over it every hour, I would by all means

advise to use heavy rails; not because the expenses of management would thereby be reduced, but principally, because no sufficient time is allowed to make the necessary repairs.

TO BE CONTINUED.

Railroads in the United States. By L. KLEIN, *Civil Engineer.*

(Continued from page 230.)

No. III.

Railroads in New Jersey, Delaware, and Maryland.

The railroads in New Jersey were constructed by private individuals without any assistance on the part of the State; the most prominent of them is the Camden and Amboy Railroad, which is the longest and has been constructed at a great expense. Nearly parallel with the same, and at a small distance only, runs another railroad, and both serve to connect the two largest and most important cities of the United States—New York and Philadelphia. The railroads in this State have all a single track, the width of which is four feet ten inches. They are used for the transportation of both passengers and freight.

There is only one railroad in the State of Delaware, connecting the Delaware river with the Chesapeake Bay. It has a double track, and was commenced as early as 1830. A part of the Philadelphia, Wilmington, and Baltimore Railroad, also passes through this State.

In the State of Maryland a great deal has been accomplished in regard to railroads. In 1828 one of the most stupendous works in the Union—the Baltimore and Ohio Railroad—was commenced; other railroads of great importance have been undertaken, and are for the greatest part finished.—The State Government has contributed much to promote the introduction of railroads, by granting loans or taking stock to a very large amount; and the city of Baltimore, aware of the incalculable advantages it must derive from being the centre of so many improvements, has liberally contributed its share to the same object. Nearly all the railroads in this State are of a very permanent construction, with a heavy T rail, and the superstructure resting upon a solid foundation; but owing to the nature of the country through which they pass, very heavy grades had frequently to be adopted. The grading is done for a double track, but only a single track is laid down. The width is four feet eight and a half inches.

Railroads completed or in progress in the States of New Jersey, Delaware, and Maryland.

No.	Name of Railroad.	From and to where.	Opened. Year.	Opened. Miles.	No. miles. besides graded.	No. miles. Not yet constr'd	Total length of road.	Dimensions or weight of iron bars or rails.	Motive power employed.	Amount of capital expended.	Amount required for completion.	Total cost of railroad	Cost per mile.
							miles			Dollars.	Dollars.	Dollars.	Dollars
1	New Jersey . .	Jersey City to N. Brunswick	1836	34			34	T rail 37 lbs.	9 locomt.	1.800.000	50.000	1.850.000	54.412
2	Paterson and Hudson	New Jersey R. R. to Paterson	1834	14			14	plate $2\frac{1}{2}\times\frac{5}{8}$	4 locomt.				
3	Morris and Essex .	Newark to Morristown .	1837	23			23	do. $2\frac{1}{4}\times\frac{5}{8}$	3 locomt.	327.000		327.000	14.200
4	Elizabethtown and Somerville . .	Elizabethtown to Somerville	1840	22		4	26	do. $2\frac{1}{2}\times\frac{5}{8}$	2 locomt.	300.000	50.000	350.000	13.462
5	Camden and Amboy	Camden to Perth Amboy	1835	61			61	T rail 38 lbs.	17 do.	2.700.000		2.700.000	29.348
6	Camden and Amboy Branch . .	Bordentown to Trenton and New Brunswick .	1839	31			30	do. 48 lbs.	2 locomt.				
7	Camden and Woodbury	Camden to Woodbury .	1833	7			7						
1	Newcastle & Frenchtown	Newcastle to Frenchtown	1832	15			16	do. 40 lbs.	6 locomt.	400.000		400.000	25.000
1	Wilmington and Susquehanna . .	Wilmington to Havre deGrace	1837	34			34	do. 42 lbs.	10 do.	3.430.000		3.430.000	49.000
2	Baltimore and Port Deposit . .	Havre de Grace to Baltimore	1837	36			36	plate $2\frac{1}{2}\times1\frac{3}{4}$					
3	Baltimore and Ohio .	Baltimore to Pittsburg and Wheeling . .	1834	85	25	325	435	T rail 52 lbs.	16 locomt	4.000.000	9.000.000	13.000.000	30.000
4	Washington Branch	B. & O. R. R. to Washington	1835	$30\frac{1}{2}$			$30\frac{1}{2}$	do. 40 lbs.	4 locomt.	1.660.000		1.660.000	54.426
5	Baltimore and Susquehanna . .	Baltimore to York .	1838	58			58	do. 58 lbs.	12 locomt				
6	Westminster Branch	Baltimore and Susq. R. R. to Westminster . .	1832	10		8	18	plate $2\frac{1}{4}\times\frac{1}{2}$	horses.	2.800.000	200.000	3.000.000	44.118
7	Baltimore and Annapolis	Elkridge to Annapolis .	1840	$19\frac{3}{4}$			$19\frac{3}{4}$		2 locomt.				
8	Eastern Shore .	Elktown to Somersetcove			20	98	118			112.500	1.400.000	1.512.500	12.818
16				$480\frac{3}{4}$	45	435	$961\frac{1}{4}$		87 locomt				

REMARKS.—Of the Paterson and Hudson, and Camden and Woodbury, Railroads, the cost of construction has not been ascertained, as also of the Elkridge and Annapolis Railroad.

The Wilmington and Susquehanna, and Baltimore and Port Deposit, Railroads, form with the Philadelphia and Wilmington Railroad (see State of Pennsylvania) only *one* line, denominated the Philadelphia, Wilmington, and Baltimore Railroad; the total cost of the whole is, 3,930,000 dollars, and the number of locomotives, 14.

In the following summary statement of the railroads in the States of New Jersey, Delaware, and Maryland, the cost of the Paterson and Hudson, Camden and Woodbury, and Elkridge and Annapolis, Railroads, has only been *estimated;* their length being inconsiderable compared with the total length of all the roads; the general results cannot be much influenced, should the estimate be a little too high or too low.

Name of State.	Number of Railroads.	No. miles in operation.	Total length of railroads.	Number of locomotives.	Amount of capital expended.	Amount required for completion.	Total cost of railroads.	Average cost per mile.
			miles		dollars.	dollars.	dollars.	dollars.
New Jersey,	7	192	196	37	5,547,000	100,000	5,647,000	28,826
Delaware,	1	16	16	6	400,000		400,000	25,000
Maryland,	8	273¼	749¼	44	12,400,000	10,600,000	23,000,000	30,700
	16	481¼	961¼	87	18,347,000	10,700,000	29,047,000	30,218

According to the above statement, there are now sixteen railroads in these three Atlantic States, with an aggregate length of 961¼ miles, of which 481¼ miles are already in operation, or nearly one half of the whole length. The number of locomotives employed upon 471¼ miles of railroads is eighty-seven, being at the rate of one engine for every 5.4 miles of road.

The sum of 18,347,000 dollars has already been expended, and 10,700,000 dollars more will be required to put in operation the still unfinished parts of several lines; of the 961¼ miles of railroads the average cost per mile will then be 30,000 dollars.

No. IV.

Railroads in the Eastern States.

The railroads in the New England States, principally those in the State of Massachusetts, are not only among the most solid and best constructed, but at the same time the most prosperous and profitable in the United States. They were all constructed by private companies, to several of which loans were granted on the part of the States. The oldest railroad not only in these, but in the whole United States, is the Quincy railroad, near Boston, completed in 1827. The longest will be the Western Railroad, extending from Worcester to West Stockbridge, a distance of 117 miles; Nearly all the railroads in the Eastern States have been graded for a double track, but with the exception of the Boston and Lowell Railroad, only a single track has been laid down. The superstructure consists mostly of wooden cross ties upon mud sills, supporting a heavy iron rail of from forty to fifty lbs. per yard. The width of track is uniformly four feet eight and a half inches.

Railroads completed and in progress in the Eastern States.

No.	Name of Railroad.	From and to where.	Opened.		No. miles.		Total length of road.	Dimensions or weight of iron bars or rails.	Motive power employed	Amount of capital expended.	Amount required for completion	Total cost of railroad.	Cost per mile.
			Year.	Miles.	Besides graded.	Not yet constr'd							
							miles			Dollars.	Dollars.	Dollars.	Dollars.
1	Bangor and Orono	Bangor to Orono	1836	10			10		2 locomt.				
2	Nashua and Lowell	Nashua to Lowell	1838	14½			14½	T rail 57 lbs.	3 locomt.	354.000		354.000	24.842
3	Boston and Lowell	Boston to Lowell	1835	26			26	do. 46 lbs.	7 locomt.	1.610.000	190.000	1.800.000	79.231
4	Charlestown Branch	Boston and Lowell Railroad to Charlestown	1839	1⅓			1⅓	do. 45 lbs.		91.028		91.028	68.271
5	Boston and Portland	Boston and Lowell Railroad to Exeter	1839	34¾			34¾	do. 45 lbs.	4 locomt.	610.000	90.000	700.000	20.144
6	Quincy	Quincy Quarries to Neponset River	1827	4			4	plate.	horses.				
7	Eastern (in Mass.)	Boston to State Line of N.H.	1839	25	12½		37½	T rail 45 lbs.	8 locomt.	1.306.196	193.804	1.500.000	40.000
8	Eastern (in N. H.)	Portsmouth to State Line of Mass.			10	5	15					600.000	40.000
9	Marblehead Branch	Eastern R. R. to Marblehead	1839	3			3	do. 45 lbs.					
10	Boston and Worcester	Boston to Worcester	1835	44½			44½	do. 40 lbs.	10 locomt.	1.848.085		1.848.085	40.000
11	Millbury Branch	Boston and Worcester R. R. to Millbury		3¼			3¼	do. 40 lbs.	horses.				
12	Western	Worcester to West Stockbridge	1839	54½	33	29½	117	do. 55½ lbs	8 locomt.	2.800.000	1.700.000	4.500.000	38.462
13	Boston and Providence	Boston to Providence	1835	42			42	do. 58 lbs.	11 locomt.	1.850.000		1.850.000	44.048
14	Dedham Branch	Bost. & Prov. R.R. to Dedham		3			3	plate $2\frac{1}{4}\times\frac{5}{8}$	horses.				
15	Taunton Branch	Bost.& Prov. R.R. to Taunton	1836	11			11		2 locomt.	250.000		250.000	22.727
16	N. Bedford and Taunton	Taunton to New Bedford			10	10	20	T rail 58 lbs.		151.039			
17	New York, Providence, and Boston	Providence to Stonington	1837	47½			47½	do. 58 lbs.	6 locomt.	2.500.000		2.500.000	52.632
18	Norwich and Worcester	Norwich to Worcester	1839	59			59	do. 56 lbs.	4 locomt.	1.360.000	140.000	1.500.000	25.424
19	Hartford and N. Haven	New Haven to Hartford.	1838	18	10	10	38		2 locomt.			760.000	20.000
20	Housatonic	Bridgeport to State Line	1839	35		38	73		2 locomt.			1.095.000	15.000
20				436	75½	92½	604		69 locomt.				

With the exception of a few short branches, locomotive steam power is used upon all the railroads for the transportation of passengers and goods. The income, which is derived principally from the conveyance of passengers, is on most of these roads very considerable, and will average fifteen per cent. annually, on the cost of construction, although the latter is higher here than of the railroads in other States.

By an existing law, the railroad corporations in the State of Massachusetts have to make annual reports of the operations of their roads to the Legislature. Much information may be derived from these reports, which would, however, be still more useful by containing more detailed data, principally in regard to the expenditures on the lines.

The foregoing statement is prepared from information attained mostly in the winter of 1839, and is therefore not complete; corrections were made from the reports, so as to show the progress of the works up to the end of 1839.

Remarks.—Of the Nashua and Lowell Railroad nine miles are in Massachusetts, and five and a quarter in New Hampshire. Of the Boston and Portsmouth, twenty-five and three-fourths miles are in Massachusetts, and nine in New Hampshire. The Providence and Stonington Railroad is nearly entirely in Rhode Island. Of the Norwich and Worcester Railroad eighteen miles are in Massachusetts, the remainder in Connecticut.

In giving a summary statement of the railroads in each of the states of New England, the cost of construction of those which are located in two states has been divided in proportion to the length of the line in each of them, as there are no data for a more correct repartition.

Name of State.	Number of Railroads.	Number of miles in operation.	Total length of Railroads.	Number of Locomotives	Amount of capital expended.	Amount requir ed for completion.	Total cost of Railroads.	Average cost per mile.
Maine,	1	10	10	2	200,000		200,000	20,000
New Hampshire,	1	14¼	29¼	2	610,000	300,000	910,000	31,111
Massachusetts,	14	270¼	365¼	52	11,100,000	2,435,000	13,535,000	37,055
Rhode Island,	1	47½	47½	6	2,500,000		2,500,000	52,632
Connecticut,	3	94	152	7	1,905,000	1,000,000	2,905,000	19,079
	20	436	604	69	16,315,000	3,735,000	20,050,000	33,195

There are in the whole 20 Railroads in the Eastern States, with an aggregate length of 604 miles; of these, 436 miles were in operation at the end of 1839, and the other 168 miles were in progress. Sixty nine locomotive engines are employed upon 436 miles of roads, or at an average of one engine upon 6⅛ miles.

The total amount of capital already expended for Railroads in New England is $16,315,000, of which $11,100,000 were expended in Massachusetts alone; with an additional sum of $3,735,000 all the Railroads hitherto commenced will be completed and the total expenditure will amount to $20,050,000, equal to $33,195 per mile at an average.

No. VIII.

In order to give a more general summary view of *all* the Railroads in the

different States of the Union, the following statement contains a recapitulation of the number and length of Railroads in operation and progress in each of the States, of the number of Locomotives employed thereon, the capital expended and that required to complete the works in progress, the total cost of the Railroads when completed, and the average cost per mile.

Name of State.	Number of Railroads.	Number of miles in operation.	Total length of Railroads.	Number of Locomotives	Amount of capital already expended.	Amount required for completion.	Total cost of Railroads.	Average cost per mile.
Maine,	1	10	10	2	200,000		200,000	20,000
New Hampshire,	1	14¼	29¼	2	610,000	300,000	910,000	31,111
Massachusetts,	14	270¼	365¼	52	11,100,000	2,435,000	13,535,000	37,055
Rhode Island,	1	47½	47½	6	2,500,000		2,500,000	52,632
Connecticut,	3	94	152	7	1,905,000	1,000,000	2,905,000	19,079
New York,	28	453¾	1317¾	45	11,311,800	10,503,000	21,814,800	16,570
Pennsylvania,	38	576½	850¼	114	18,070,000	5,042,000	23,112,000	27,183
New Jersey,	7	192	196	37	5,547,000	100,000	5,647,000	28,826
Delaware,	1	16	16	6	400,000		400,000	25,000
Maryland,	8	273¼	749¼	44	12,400,000	10,600,000	23,000,000	30,700
Virginia,	10	341	369	42	5,201,000	250,000	5,451,000	14,772
North Carolina,	3	247	247	11	3,163,000		3,163,000	12,806
South Carolina,	2	136	202	27	3,200,000	800,000	4,000,000	19,802
Georgia,	4	211½	640½	17	5,458,000	4,320,000	9,778,000	15,266
Florida,	4	58½	217	5	1,420,000	2,400,000	3,820,000	17,604
Alabama,	7	51	432½	3	1,222,000	3,434,000	4,656,000	10,763
Louisiana,	10	62	248¾	20	2,862,000	1,834,000	4,696,000	18,880
Mississippi,	5	50	210½	8	3,490,000	2,240,000	5,730,000	27,221
Tennessee,	3	0	160½	—	1,100,000	855,000	1,955,000	12,180
Kentucky,	2	32	96	2	947,000	1,250,000	2,197,000	22,885
Ohio,	6	39	416	1	420,140	2,859,000	3,279,000	7,883
Indiana,	2	20	246	2	1,375,000	3,425,000	4,800,000	19,512
Michigan,	10	114	738½	8	1,896,000	5,653,000	7,549,000	10,222
Illinois,	11	23	1421	2	1,832,500	15,177,500	17,010,000	11,970
Total.	181	3332½	9378¼	463	97,630,440	74,477,500	172,107,940	18,351

It appears, from the above table, that at the end of 1839 *the number* of Railroads completed and in progress in twenty-four States of the Union, in which this kind of improvement has already been introduced, amounted to 181, of which 3332½ miles were opened and in use; 1707¼ miles were besides graded and ready for the superstructure, and the total length of all the lines undertaken was not less than 9378¼ miles.

The number of Locomotive Engines employed upon all the Railroads in the United States, was at that time 463, (about one Locomotive for every seven miles of road.)

As accurately as could be ascertained, the total amount expended on all the works, up to the end of 1839, was $97,630,440, the amount still required to complete the works that were commenced, was $74,477,500, and the total expenditure for Railroads, when all the works in progress will be completed, will be $172,107,940. If this latter sum be divided by 9378¼ (the length in miles of all the 181 Railroads) we obtain $18,351 as the average cost per mile of Railroad with a single track,* including buildings, fixtures and outfit.

* Compared with the total length of all the Railroads, the length of those with a double track is inconsiderable.

Many of the Railroads in progress will, perhaps, cost more than has been estimated for, but even if the actual cost should exceed the estimates by $15,000,000, the average cost per mile of Railroad will not be more than $20,000.

Mr. D. Stevenson in his "*Sketch of Civil Engineering in North America,*" (London, 1838,) gives a list of all the Railroads completed and in progress in 1837. According to his statement, there were at that time 1652¼ miles of Railroads in operation, and 2,760 miles in progress. The extent of Railroads put into operation since 1837, or during the last three years, is therefore 1680 miles, being at an average of 560 miles per year; it must, however, be remarked that the extent of Railroads put into operation in 1839 was less than might have been expected, owing to the difficulty of raising loans in Europe. If only half the length of lines which were graded had been completed, the number of miles in operation at the end of 1839 would have exceeded 4100, as was anticipated by the late Chevalier de Gerstner.

TO BE CONTINUED.

Physical Science.

Notices of the Weather, and Meteorological Observations made at Nashville, Tennessee. By Prof. James Hamilton.

Meterological Summary July 1840.

Mean temperature 78°.04.; max. 95°, on 17th, 18th and 29th., min. 60°, on 3d; range 35°—mean of Bar. 29.604.; max. 29.73, on 26th; min. 29.40, on 13th and 23d; range 0.33. The maximum temperature occurred before noon on the 10th, 11th, 17th, 18th, 19th, 28th, 29th, 30th, 31st days. There were several showers between the 7th and 24th days, and those of the 8th, 9th, 22d and 23d were quite heavy. Rain fell on 10 days—amount of rain 5.05 inches. Of 93 observations on the state of the sky, 43 were clear, 40 cloudy and 10 rainy. Of an equal number on winds, 4 were from the N., 25 NE., 3 E., 5 SE., 48 SW. and 8 W. Warmest day the 29th, and its mean 85°.

August.

Mean temperature 77°.24., max. 96°; on the 3d, min. 55°; on the 9th, range 41°—mean of Bar. 29.590; max. 29,83; on 18th, min. 29.42; on 13th, range 0.41. In this month also, the max. temp. was during the forenoon. On the 4th, 5th, 6th, 7th, 10th, 12th, 14th, 21st, 22d, and 24th, 10 days of rain—amount 4.90 inches. Clear observations, 61—cloudy 32. Winds, 5 N., 17 NE., 3 E., 4 S·E., 48 SW., and 16 West. Dews heavy after the middle of the month, and morning fogs from the 25th to the 29th inclusive—very little thunder during July and August—warmest day 3d, with a mean of 86°.

September.

Mean temp. 66°35; max. 88°, on 8th; min. 43°, on 19th; range 45°. Mean of Bar. 29.634; max. 29.86, on 13th; min. 29.42, on 20th; range 0.44. The mean temp. at noon exceeded that at 3 P. M., by two degrees. 7 rainy, 12 clear, and 11 cloudy days—amount of rain 3.04 inches. Of 90

obs. 48 clear, 36 cloudy, and 6 rainy. Winds, 10 N., 17 NE., 8 E., 2 S.E., 34 SW., 10 W. and 9 NW.

N. B. The storm noticed in the last report as occurring on the 20th of June, took place on the 21st.

Hourly Observations made at the Univerity of Nashville, Tenn., during the Autumnal Equinox, 1840.

SEPTEMBER 21.

A. M.	Ex. Thr.	At Thr.	Bar.	Weather.	Wind. Direc.	Force.	
6	52	65	29.55	clear.	NE.	1	Min. 52°. Hazy
7	54	66	.57	do.	do.	1	in the horizon all
8	57	66.8	.59	do.	do.	2	this day.
9	60	67	.59	do.	do.	2	Dew point 47°
10	63	67	.595	do.	do.	1	
11	66	67	.588	do.	do.	2	
12	68.5	67.25	.583	do.	do.	3	Dew point 47°.5
1 PM.	70.5	67.5	.580	do.	do.	2	
2	70	68	.574	do.	do.	3	
3	69.5	68	.570	do.	do.	5	Dew point 47°.5
4	69.5	68	.580	do.	do.	3	
5	68	68	.591	do.	do.	3	
6	65	68	.610	do.	NE. by E.	1	
7	62	67.5	.630	do.	do.	2	
8	59	67.25	.640	do.	do.	2	
9	58	67	.645	do.	do.	2	
10	56	66	.650	do.	do.	1	
11	54.5	66	.660	do.	do.	1	
12	52	66	.665	do.	do.	0	Dew point 56°

SEPTEMBER 22.

1 AM.	50	66	.670	do.	E. NE.	0	
2	48.75	65	.660	do.	do.	0	Dew point 54°
3	47.5	65	.660	do.	do.	0	
4	47	64.5	.680	do.	do.	0	
5	46	64	.687	do.	E.	0	
6	45	64	.705	do.	do.	0	
7	50	64	.710	do.	do.	0	

Franklin Institute.

Address delivered before the Franklin Institute at the close of the Eleventh Exhibition of American Manufactures, on Wednesday Evening, October 22, 1840. By FREDERICK FRALEY, ESQ.

Less than two centuries ago the place where we are now assembled, and the whole of the fair territory which forms the American Union, were the habitation of uncivilized man, depending upon the precarious chance of the chase, and the spontaneous bounty of Nature, for his support, and protected from the changes of the climate by the skins of the animals which his skill

in hunting enabled him to overcome. What forms the history of our nature, gradually emerging from such a rude state, is the history of the world; and while each generation has contributed something to make mankind more skilful, more wise, and more happy, it is the distinguishing characteristic of the age we live in, that the discoveries in the sciences and useful arts have been multiplied beyond all previous times; that new sources of wealth and prosperity have been opened; and that the means for making our knowledge universal, have been increased by the rapidity with which new discoveries are communicated from nation to nation, and by the general diffusion of education, enabling all to sieze upon the moving mass, and intelligently to shape and fashion it to their individual purposes. If we look back for the brief space of about ten centuries, we find that the great nations of modern times, whose ships now swarm in every sea, bearing the products of their varied industry from land to land, and by an interchange of benefits, bringing the extremities of the earth into one common brotherhood, were hampered by systems of government, which made war and conquest the great business of the people, and regarded the artisan and agriculturist as beasts of burthen; whose persons and property might be transferred from one master to another, at the will of him who wielded the most successful sword. But the stern necessity which compelled the conquering chieftain to protect his acquired territories, and to shine in the martial chronicles of the day, also called upon the artisan to fabricate new instruments of attack and defence; to provide stores of clothing and provisions, and to construct vehicles bywhose means armies and their stores could be transported from place to place. The same necessity required that the husbandman should be protected in his labour, that the fields and flocks which furnished food and clothing, should be well attended to, and the wise and daring chieftains of feudal times soon discovered, that in order to place their power upon the surest foundation, it was necessary to elevate the condition of their feudatories, by giving them a direct personal interest in their own labours, and changing the precarious supplies which were reluctantly conceded to absolute power, to the more congenial plan of a fixed and permanent participation in the labour and industry of their vassals.

The stimulus of individual interest soon doubled and quadrupled the products of the soil, and the workshops, whose tenants had unwillingly forged the shield, the javelin, or the sword, or fabricated the vestment of the soldier, began to sound with the busy hum of cheerful and free industry, and amassed those treasures of labour which form the objects of commerce. These accumulations of industry gradually liberated a portion of the people from the necessity of an actual participation in the business of production, and converted them into mariners and merchants, whose adventurous spirit, carrying them beyond the narrow boundaries of their respective lands, caused an interchange of the surplus productions of each; and while the fruit of such voyages created new wants in every country, those wants were met by the steady and successive efforts of the powers with which the Creator has endowed mankind; and the results are now apparent all over the civilized world, in their improved forms of government, in the evidences which are furnished by their houses, ships, clothing, and agricultural productions, in the great chains of canals and railroads which bind together the different interests of each community, and stretch forth willing arms to connect them with adjoining States; but above all are these results to be prized, because they have led man to elevate himself above his merely animal nature, and to seek in the cultivation of his mind, the realization of

that similitude to his Maker, which the light of nature shadowed forth to the ancient heathens, but which the book of revelation has confirmed to us by the direct inspiration of his spirit. We turn to our own country, and we behold that the settlements which a few pilgrims and adventurers from Europe planted on our shores, have grown into a mighty nation, second to none in the wise and liberal spirit of its government, in the general intelligence of its citizens, and in the perfect adaptation of the soil and climate where it is located, to furnish us with every thing, which but for the sympathetic cord which connects us with the entire world, might lead us to avoid all intercourse with other countries. But, happily, the spirit which was impressed upon our institutions at their foundation, leads to no such result. The cold hearted colonial policy, which bound us with the iron fetters of dependence upon the mother country, while we were in our infancy, found no favor with us when we assumed our place among the nations of the earth; and a wise, equal, and just system of commercial regulations has, from that time up to the present, been signalized by an unexampled increase of wealth, population, and prosperity.

Until the spirit of the American revolution began to show itself in the determination of the people to avail themselves of their natural resources, and of their power to supply themselves with many things which, if manufactured at all, were done so clandestinely, the policy of England had been to prevent every thing like manufactures from being prosecuted at all among us; and the unnatural spirit which dictated such a course, had only to glory in a very restricted trade, which benefitted neither the parent state nor the colonies.

As soon, however, as we achieved our national independence, the benefits of a more liberal system became apparent; and as we added ship to ship, and manufactory to manufactory, the tide of national greatness swelled over our country, and continued to roll on until it has conducted us to the time which it is the purpose of this address to mark. We are surrounded in these halls by the most gratifying evidence of the skill of our manufacturers and mechanics, and of the capacity of our country to furnish the raw materials on which the ingenuity and talents of our citizens may be exerted. Every thing is here which necessity could crave, which comfort could desire, or which luxury and wealth are competent to command; and when we reflect in what minute channels the principle of industry must run to elaborate the delicate and costly articles of this display, and what a mighty grasp of mind must have been needed to frame the machinery and to superintend the processes which have yielded the various fabrics of cotton, wool, and iron, which crowd our stands and tables, and indicate the true state of the arts among us, as well as the extent of the products of those arts, the mind can scarcely realize the fact, that all this has been accomplished by a nation not yet numbering three-quarters of a century in age, whose population, at the same time, has been employed in clearing the forest, and winning our soil from the wilderness, in building vast cities, in opening roads and canals, and in contributing, by the immense productions of her agriculture, to the support of the commerce and manufactures of the great European nations, from whom a large portion of that population has been derived. Nor while we have thus been so actively employed in the mere fabrication of such masses of industrial productions, has the genius of our citizens slumbered, nor have we been wholly dependent upon the machinery invented by foreigners for the accomplishment of these great results. The cotton gin of Whitney, eliminating the food for the gigantic produetions

of the machinery of Arkwright, Cartwright, and others, is but one triumph of genius in the series of American inventions which sometimes seized upon the idea that a foreign brother mechanic had struck it, but more frequently with native originality compassed the whole machine which has given a new direction to national industry.

The discovery of the quadrant by Godfrey; the successful application of steam to navigation, by Fulton, Rumsey, and Fitch; the untiring devotion of Evans, to multiply the uses of that potent agent, and to simplify the ponderous engines of the distinguished Watt, and the infinite number of new and useful inventions which claim the American name, all go to prove that we have contributed our full share to the mass of useful knowledge, and that our country presents a gratifying and conclusive evidence of the tendency of popular institutions, of freedom of thought and of action, to work out the highest and noblest destinies of man. While we have thus prospered as a nation; while the names of American inventors and their works are known and appreciated in foreign lands, we have also been associating together for the purpose of mutual instruction and inprovement; and Schools, Academies, Colleges, and Scientific Institutions, are to be found scattered broad cast throughout the land, ministering to that boundless thirst after knowledge which characterises us as a people. Our own State has not fallen back in this noble and generous emulation; the character which the hand of her illustrious founder impressed upon her Institutions, the wise, just, and liberal policy with which his noble mind sanctified his treaties with the aboriginal inhabitants, and his agreements with the original settlers, have all combined to render Pennsylvania the abode of Science, and to make her distinguished among her Sister States, for her encouragement of Education, for her care of the great interests of her people, and for binding that people together by the enduring facilities of intercourse among each other. The original frame of government for the province and each of the Constitutions which have since been adopted by the people, contained provisions which declare the duty of the State to watch over the education of the people, and to encourage the Arts and Sciences; and the establishment of the University of Pennsylvania, of several Colleges and Academies, the incorporation of the American Philosophical Society, the Academy of Natural Sciences, and several Associations of a kindred character at a very early day, shews that those salutary features of our fundamental law have not been neglected either by the citizens or their legislators. Connected with these early Institutions was a very imperfect system of popular instruction, and the Arts and Sciences seemed to be widely sundering from the mechanic and manufacturer, when a few energetic and philanthropic gentlemen of this city determined to establish the Franklin Institute, and to form by its means a series of continuous and appropriate links between the ordinary schools of the State, the workshops, and the higher circles of scientific pursuit. The regulations of the Institution were framed on the most comprehensive and popular basis, and the support which it has hitherto received may be relied upon as a sure index of its continued success and usefulness. By its Schools Lectures, Exhibitions, Committees on Inventions and Science and the Arts, and in its Journal, Library and various collections of Models, Minerals, Materials and Fabrics, it possesses the means of diffusing practical knowledge, of testing the value and usefulness of new discoveries, and of checking the dangerous flights of uneducated genius. It enables the Man of Science to commune on the same platform with the practical mechanic, and to blend the truths of Theory with the more rugged ways of the work-

shop, thereby enabling the philosopher to start from a higher point, and the workman to dispense with processes which he had before deemed essential to his Art. Since the successful establishment of the Institute in 1823, similar Institutions have been formed in our own State, and in several other States, and the benefits which have been realized from them are in a great measure exhibited by what we have before us now; showing the accurate knowledge of principles, the perfection of workmanship, the skill in combination, and the beauty and variety of ornament which characterize the daily productions of our looms, forges, laboratories and workshops. Nor are these tangible evidences all; we find an animated intelligence beaming in almost every eye, an awakened interest in what is passing in the varied world around us, and each man feels the necessity of understanding the principles of Science, and of learning what constitute the great discoveries of the day, to enable him to walk erect among his fellows, and to share in the high intellectual enjoyments which he perceives are at their command. To some of us who have been connected with the institution from its origin, the results which it has accomplished appear almost like the fabled creations of Aladdin's lamp. Each succeeding year has increased its members, the thirst after knowledge has remained unquenched, and its revenues have been found entirely inadequate to feed the noble flame which burned in the hearts of those who are seeking knowledge at its shrines. To meet the wishes of its members for enlarged facilities of instruction, and to extend, by a more commodious and larger building than its present Hall, the accommodations for its cabinets and meetings, the structure in which we are now assembled and its site were purchased about five years ago under promises of public support, which up to this time have not been realized; and the institution has been compelled to abandon, for the present, the project of erecting a new Hall, and must endeavor to dispose of this building without any further sacrifice of its ordinary income, which has already been deeply trenched upon in the effort to secure so desirable an object.

While, however, it has been disappointed in erecting a substantial and suitable edifice for its purposes, the vigorous zeal which has distinguished the prosecution of other labors has not flagged. The arrangements for instruction during the coming winter comprehend regular courses on Chemistry, Natural Philosophy, and Mechanics, Technology, Architecture, and Geology; with occasional discourses on other branches of knowledge. The library, already numbers several thousand volumes, and is steadily increasing, and by means of the journal a crowded reading room is kept constantly supplied with the best periodical literature of the day, with newspapers from all parts of our own country, and with every valuable journal published in Europe, devoted to the advancement of the sciences and useful arts. A drawing school under the care of one of our best teachers, is kept open during six months in every year, and while the instruction afforded in it has been placed by a moderate fee within the reach of every industrious apprentice, the additional advantage of admission to the lectures without additional charge, offers to every pupil of the school under twenty-one years of age, a course of instruction which could not be commanded elsewhere without the payment of a sum much larger than could be conveniently spared from his earnings. The arrangements for the admission of the sons, apprentices and wards of members have been framed on the same liberal basis: the sum of one dollar entitling such persons to attend all the lectures of the Institute; and ladies can also obtain the ticket of admission to the several courses by the payment of two dollars annually. A meeting for

conversation on mechanical and scientific subjects is held once in each month, with the exception of the months of July and August, a free and familiar interchange of opinion on the great discoveries of the day, and of inquiry into the different processes of art and manufactures are thereby presented in a form which can be participated in by those who would shrink from a more formal exhibition of their proficiency in the departments of science and useful industry to which they devote their time and attention. A committee on science and the arts to which every member of the Institute may voluntarily attach himself, is constantly engaged by its sub-committees in investigations pertaining to theoretical Mechanics, in examining new machines or improvements in those in general use, in testing the value of new processes, and in advising those whose genius has either in whole or in part been anticipated by others, what part of their machines or processes have been known before, what theoretical or practical difficulties impair the value of their discoveries, when they are new, and to what sources they may direct their attention and labors with advantage; and in rewarding, by the Premium and Medal established by John Scott of Edinburg, the distributions of which have been confided to the Institute by the City Corporation, such Inventions and Discoveries as may be worthy of that honorable distinction. The reports of their sub-committees are regularly brought before the Committee at its monthly meetings, and thus the whole field of practical research is kept before the eye of every one, who thinks proper to devote an hour or two periodically to the subjects which have been in this manner brought under examination. The other departments are placed in charge of appropriate Committees, and the whole forms a Polytechnic and Scientific Institution every way worthy of your liberal and enlightened patronage.

We are about to close this Exhibition of the products of our native industry, and the occasion may be improved by a brief examination of the advantages which such displays afford. Viewed in the mass, they gratify our proper National pride, and by developing the resources of our country, naturally withdraw our attention from an habitual and too general dependence on other lands which are supposed to be favoured with great facilities for production, and turn us with stronger affection and confidence to those channels of supply, which patriotism and independence have already marked upon our soil, and which a steady and generous support will widen and deepen until they become capable of furnishing every thing, which, as a people forming part of the great family of Nations, and maintaining a proper and reasonable intercourse with the rest of the world, we could desire. In their particular benefits, it may be truly said that they furnish Manufacturers and Mechanics with opportunities for comparing their own work with that furnished by others; of detecting individual defects and excellencies, of softening down mutual prejudices, and where great skill and ingenuity have been shown, to make that skill and ingenuity a sort of common property, to be availed of, either for present advantage, or to be made the basis of new improvements in the fabrics which form the subjects of the skill and industry of our citizens. Further, they are calculated to enlarge our National Commerce, by furnishing articles which neighboring nations and which different parts of our own Country less capable of manufacturing, are continually requiring, to enable them to conquer the forests, to open their soil, to clothe their inhabitants, to build and furnish their houses, and to contribute their share to the beneficent design of Providence which makes all mankind brethren, by making them in some degree dependent upon each other. While the loom, the forge and the workshop owned

by the civilized, refined and educated European or American, contribute to the natural appetite of the savage or the half civilized man for display and ornament; it must not be forgotten, that the spoils of the chase, the spontaneous productions of the earth, and the golden sands which come from the lands which own the savage and the uncivilized for their lord, are equally prized by us; and that if they value the scarlet cloth, the showy bead, or the glittering mirror, we clothe beauty and dignity with the fur of the ermine and the sable; we adorn our houses, temples and persons with the gold and precious stones and costly woods of their lands; and we fill our tables with the fruits and spices, with the luxuries and necessaries of life, which their generous soil and favorable climate yield. While the articles which form the media, by which these national exchanges are effected, are here represented, we have only to look a short distance beyond these walls for the ships, the mariners, and the merchants by whose agency they are transported to their appropriate markets. The golden fleeces of Commerce, the rich rewards of Agriculture, and the prosperity of our Manufactures, are all dependent upon each other; and if any one of these great departments of human employment be suffered to languish, decay and ultimate ruin will soon destroy them all. We read this admonitory truth in all the pages of History. Where is now the Commercial importance which made the ancient Tyre, and the more modern Venice, Queens among the cities of the earth? Where in the rank of nations stand Spain and Portugal, by whose citizens America was discovered, and the ready and successful way to the great East opened? Where, in fine, are the lands which gave birth to the liberal and useful Arts, whose Poets and Philosophers even at this day teach us the lessons of Wisdom, and the beauty and harmony of language? All, all, have been sunk either by the vices or the imbecility of their rulers, by an abandonment by their inhabitants of the true sources of National Wealth and greatness; and by the influence of that policy, which deems ourselves much wiser than our neighbors, and is contented to stand still while they are seeking to avail themselves not only of National advantages, but of the improvements which Science and Enterprise place within their control.—We of Pennsylvania must especially take these truths to heart. We have been blessed with a fertile soil, with hills and valleys teeming with mineral wealth, with a free government, with citizens who in past times have kept foremost in the ranks of the Union for their Agriculture, Commerce and Manufactures, who have clothed our roads, rivers and canals with the mantle of the Commonwealth, who have built and endowed colleges, academies, schools, asylums and other institutions, and who have placed in our hands those peaceful weapons with which the noblest and most enduring triumphs of nations are achieved. Let us see to it then, that we fall not back among the nations; let us seize upon every thing which is calculated to make us wiser, better, more skilful and more prosperous.

Let not a seeming disadvantage in the location of our metropolis, at a point a little more distant from the great highway of nations than some of our neighbors, make us forego the advantages which a new application of the discovery of our own Fulton now promises in the world; or the consciousness of what we have accomplished induce us to fold our arms in contempt of the great struggles of the nations for superiority; but with a noble and generous spirit, cherishing every institution which promotes our agriculture, which instructs our mechanics and manufacturers, which educates our merchants and mariners, make all our citizens sensible of the duties they owe to the world, and competent to discharge those duties with wisdom and

intelligence. Above all, let us cherish public and private virtue as the best and surest foundation for national happiness; and then, when the days which Providence may allot to us as a people, have been fulfilled, succeeding ages may find in our institutions, monuments, and history, the lights which will guide them to the same honorable elevation that we have reached; and beacons to warn them of the errors which have marked our decline and downfal.

Eleventh Exhibition of Domestic Manufactures held by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts.

To the Managers of the Franklin Institute:

The Committee on Premiums and Exhibitions respectfully present their Report in relation to the Exhibition which has just closed.

The preparations for holding the exhibition were in general similar to those which were made in the years just preceding this. A circular, giving notice of the time of holding the exhibition and soliciting contributions to it, was widely distributed. The number of premiums and the specific kind of articles for which they were to be awarded, were again left to be determined at the exhibition itself, a course adopted at the last exhibition, and in relation to which the advantages anticipated by the Committee have been fully realized.

Preliminary meetings of a Committee of Arrangement were held at the Hall of the Franklin Institute, during the month of September, and were attended by upwards of one hundred members. At these meetings sub-committees were appointed to obtain and arrange specimens in the different departments of the Arts and Manufactures, and the reports made from time to time of their progress, showed great zeal and spirit in the performance of their duties, and gave promise of the results subsequently attained.

It is believed that the Committee on Premiums and Exhibitions has been enabled, by the experience of past years, materially to improve the general business arrangements of the exhibition. The distribution and arrangement of the rooms, the erection of the temporary building in front of the Hall, the opportunities of exhibiting the stoves and grates in action, with other minor matters promotive of the convenience of visiters and of the advantage of depositors, were all improvements on the similar arrangements of former years. The Committee were further enabled, by the kind co-operation of the gentlemen of the United States Mint, to have a supply of medals adequate to the probable demand prepared in anticipation, so that the actual delivery of the medal to a successful competitor for a premium might be made during the exhibition itself.

These endeavours having met a corresponding return on the part of the depositors of American products, and the choice of the articles which the market for the several kinds affords, has been presented for competition or submitted to the examination of the public. Many articles were prepared expressly for the exhibition, but it is to be remarked of this occasion more than of any which preceded it, that more articles in proportion were of the kind to be purchased by consumers, and not mere show specimens, of the best efforts of the manufacturer. The result is highly gratifying, as showing considerable progress in many departments of industry. Much of this result may fairly be claimed for, and part of it is directly traced to, former

exhibitions here or elsewhere. Of course, if there is no demand for an article, the mere award of an honorary premium or medal, however gratifying to the producer, will not secure a steady advance in, or even the continuance of, a manufacture, but in the articles for which there is a real demand, such exhibitions promote improvements in various ways. The condition of the manufacture is spread before the manufacturers themselves, and they are incited to exertion to carry it a step forward, to outdo their former efforts or those of competitors. They see what is required, and their ingenuity is set to work to produce it. The public see the results of this competition and effort, their observation induces them to supply themselves with the articles they require from approved sources, the relative merits of different products are canvassed, the manufacturer feels immediately, or in time, the consequences of his successful labour, and in some cases considerable orders are given during the very exhibition itself. It is almost impossible that a branch of manufacture should remain stationary under the influence of these exhibitions; experience shows, on the contrary, that the advance in many is so rapid that articles which at one time have been highly praised become obsolete, if not subsequently improved upon.

The public have patronized this exhibition well, notwithstanding many unfavorable circumstances connected with the time of holding it, and the unusual character of the weather for a considerable part of the fortnight during which it was continued. Committees from the Massachusetts Charitable Mechanics' Association of Boston, from the Mechanics' Institute of New York, and from the American Institute of the same city, have visited our exhibition, the compliment was the greater on the part of the latter society, as they were themselves holding a similar fair, requiring great activity and energy in the members to carry it successfully on. It is believed that all these gentlemen were satisfied with the results of their visits, and in reference to some particular departments, they did not hesitate to award the palm of merit to our mechanics.

By invitation of the Committee on Premiums, a part of the pupils of the Public Schools, and of some other institutions of our city, with their teachers, attended the exhibition, and it is hoped with immediate advantage to themselves, and perhaps with more important prospective benefit.

Great efforts have been made to induce punctual attendance and prompt reports by the committees appointed to judge of the relative merits of articles submitted for competition, and with good success. The Committee on Premiums, on their part, have given corresponding attention to the award of premiums and certificates, and to the preparation of their report; and it is a distinguishing feature of this exhibition that the medals and honorary certificates were awarded during the exhibition itself. At the same time the arrears of former years in the delivery of medals were brought up, and the members of the Institute had an opportunity of hearing an excellent and appropriate address on the connexion of Commerce and the Mechanic Arts, by the Treasurer of the Institute, Frederick Fraley, Esq.

As the awards of certificates at these exhibitions are more generally for improvement or perfection in manufacture than for novelty in invention, a certain class of models and machines has not heretofore met with all the attention which, in the opinion of many, they deserve. This defect has been remedied by referring such articles to the attention of the Committee on Science and the Arts, by whom, if desired by their inventors, they will be duly examined, and who are authorized by the city authorities to award, un-

der the Scott's legacy, medals and premiums for meritorious inventions. The careful investigation which such matters require is thus secured for them.

The Committee now proceeds to give a general view of the results of the exhibition, the awards of premiums and certificates being usually made in conformity with the reports of the judges; the Committee having, however, the power of, and exercising a discretion in, revision, when the cases seem to them to require it, and having made personal examination when the judges omitted to report, they have endeavoured to do what was right in the premises. As usual, many articles have been excluded from certificates by being brought to the exhibition after the specified time, the Committee having only sparingly and in special cases exercised the right reserved to themselves of examining articles of considerable claims to merit, but which were excluded from the examination of the judges by being presented too late for that purpose.

Cotton Goods.

The goods exhibited in this department were, very generally, samples of those to be had in quantities in the stores, and fully sustained the character of the exhibition. A more particular account of them with remarks from the judges, will be appended to this report. The Committee has, in conformity with the report of the judges, made the following awards:

To J. Dunnell & Co., of Pawtucket, R. I., for samples, No. 629, six pieces of $\frac{4}{4}$ chintz prints, "of superior excellence. The printing consisting of several colours, unusually perfect, and the style beautiful."

A Silver Medal.

To James C. Kempton, of Manayunk, Pennsylvania, for his power loom ginghams and power loom checks. (No. 435.)

The judges state that these are new articles, and that the "entire execution including the dyeing, is very superior." As the weaving with three shuttles on the power loom is supposed to be a novelty, the subject has been referred for examination to the Committee on Science and the Arts, and in the mean time the Committee awards for the execution of the goods prescribed,

A Silver Medal.

To Ebenezer Rhoads, Boston, Massachusetts, for white cotton counterpanes, (No. 257.) A Certificate of Honourable Mention.

To Smith, Dove & Co., of Andover, Massachusetts, for No. 290, deposited by Parker & Iddings, shoe thread of uniform fineness and due strength,

A Certificate of Honourable Mention.

To John Hopkins, of Philadelphia, for No. 674, cotton and woolen hose, shirts and drawers, of "fair texture, and for durability and service, at least equal to the imported," A Certificate of Honourable Mention.

To the Rockland Manufacturing Company, for specimens of cotton yarn, (No. 879.) A Certificate of Honourable Mention.

Woolen Goods.

The samples of woolen goods were not as numerous, nor as varied as in former exhibitions; nevertheless the display was creditable to the manufacturers. In conformity with the remarks of the judges, the Committee has made the following awards:

To the Middlesex Manufacturing Company, for cloth No. 250 and 251, deposited by the makers—and consisting of olive, brown, and blue diamond cloth, and of green and blue asphaltum cloth of superior style and finish,

A Silver Medal.

The judges remark of the diamond cloth, that it is a new article.

To the Middlesex Manufacturing Company, for lot No. 250, deposited by the makers, Wool black and Oxford mixed cassimeres.

A Certificate of Honourable Mention.

The wool black cassimeres of this lot were particularly admired.

To Edward Harris, Woonsocket, R. I., for lot No. 252, deposited by the manufacturer—blue and cadet mixed jeans, in relation to which, while the specimens are considered very beautiful, more weight is deemed desirable.

A Certificate of Honourable Mention.

To the Mechanics' Manufacturing Company, of Rochester, New Hampshire, for specimens of three point white, scarlet, and green Mackinaw, and of satin bound and embroidered milled bed blankets, (No. 314.)

A Certificate of Honourable Mention.

To the Salisbury Manufacturing Company, of Boston, for lot No. 575, deposited by Waln & Leaming, and consisting of specimens of printed scarlet flannel, and thirty-six and forty-five inch white shirting flannel.

A Certificate of Honourable Mention.

To J. & J. Eddy, Fall River, Massachusetts, for No. 689, specimens of double-milled drab sattinets, "very heavy and firm, and well coloured."

A Certificate of Honourable Mention.

To the Ballard Vale Co., Massachusetts, for lot No. 792, $\frac{4}{4}$ and $\frac{7}{8}$ white flannels. A Certificate of Honourable Mention.

Several articles in this department were, owing to the late period at which they were brought to the exhibition, excluded from competition.

Wool.

A beautiful specimen of wool from was deposited by C. Houston & Co., and the Committee believing that this may hereafter become an article of great importance to the United States, and desirous of competition in it at future exhibitions, awards

A Certificate of Honourable Mention.

Carpets.

To George Dudley, of Philadelphia, for No. 36, a superior imitation Brussels carpet, much admired. A Silver Medal.

The velvet pile carpet of the same maker, was in too small a quantity to obtain a special mention, though the quality was deemed excellent.

The tufted rug, by the same maker, was considered good both in quality and colour.

To Isaac Macauley, of Philadelphia, for No. 762, deposited by the maker, oil cloths of excellent quality and colours.

A Certificate of Honourable Mention.

To George W. Duncan, of Philadelphia, for No. 56, deposited by the maker, oil cloths for table covers. A Certificate of Honourable Mention.

Silk.

The display in this department was decidedly superior to that of former years, and satisfactorily shows that certain articles have actually taken their places among the manufactures of our country. The specimens of sewing silk were of good quality and colour, and the material prepared for this manufacture was presented in considerable quantity. The following awards are made:

To the Philadelphia Silk Culture and Manufacturing Company for sewing silks of assorted colours, of good quality, and well dyed, deposited by E. O. Abbott. A Silver Medal.

To Mrs. H. M'Lanahan, Superintendent of the Model Filature at Philadelphia, for a small but beautiful specimen of reeled silk, prepared by herself. A Silver Medal.

To Thomas R. Fisher, of Germantown, Pennsylvania, for silk stockings, gloves, drawers, &c., manufactured by him.
A Certificate of Honourable Mention.

To the Association of New Harmony, Pennsylvania, for a specimen of figured silk ribbon, deposited by Charles Joy.
A Certificate of Honourable Mention.

The Committee regret that the late date at which the sewing silk and other articles, made by John Wilbank, of Philadelphia, were deposited, excluded them from the notice of the judges. The specimens of sewing silk and silk handkerchiefs deposited by Adam Brooks, derived special interest from the fact that the manufacture is understood to be conducted at one process (on a machine of his invention) from the cocoon to the manufactured articles; the Committee had not sufficient information herein to enable them to make an award in the matter.

Iron and Steel.

In this useful department the report of the judges is full and explicit, and the awards have been made according to their recommendations.

To the Boonton Iron Works, New Jersey, for a specimen of wrought iron manufactured by anthracite coal, and from anthracite pig metal.
A Silver Medal.

The pig metal was made at the Crane Iron Works, and the judges remark of the malleable iron, that it is of good quality; they refer also to the statement of the maker, that the pig metal was converted into malleable iron with a very trifling cost, and derive great encouragement from it in reference to the future prospect of the manufacture of Iron by anthracite in our country.

To Savery & Co. of Philadelphia, for their specimens of hollow iron, and other iron castings of beautiful execution. A Silver Medal.

The fine castings, by Levi Morris & Co., are beautiful specimens of the art of the founder,—the ornamental iron dishes and castings of the Madonna, are a near approach to the Berlin castings. As Isaac P. Morris of this firm is a member of the Board of Managers of the Institute, the Committee can make no awards.

To Yearsley and Forsyth, for three sheets of boiler iron of unusually large dimensions, deposited by Morris & Jones.
A Certificate of Honourable Mention.

One of the sheets is ten feet six inches in length by thirty-one in breadth; it is from a charcoal bloom, and each sheet is said to have been rolled at one heat.

To Valentines & Thomas of the Bellefonte and Juniata Iron Works, for several specimens of iron, deposited by E. J. Etting & Brother.
A Certificate of Honourable Mention.

To the Coleman Iron Works, Mastic Forge, Lancaster county, for a specimen of pig iron made from charcoal with the hot blast, by the run out process. A Certificate of Honourable Mention.

Specimens of anthracite pig iron, were also deposited by W. R. Johnson, by Baughman Guiteau & Co., by Biddle, Chambers & Co., on which the judges remark, that they are all good, and present considerable varieties in their qualities, adapting them to different uses.

The judges were of opinion that the plate exhibited was not superior to that presented at former exhibitions.

Lamps and Gas Fixtures.

There was not a great variety in the articles of this kind exhibited, but some were of great excellence. The Committee makes the following awards:

To Cornelius & Co., for several lamps and gas fixtures, deposited by them. A Certificate of Honourable Mention.

The judges are informed that the silvered mounting of some of the articles exhibited by Messrs. Cornelius, is covered with a varnish, which, though not perceptible to the eye, protects the silvering from the action of gases.

To the Boston and Sandwich Glass Company, of Massachusetts, for two glass shades of pendant hall lamps, of a hexagonal form, and cast in one piece, deposited by W. M. Muzzey.
A Certificate of Honourable Mention.

Hardware and Cutlery.

The collection of these articles did great credit to the manufacturers, and manifested excellent judgment on the part of the Committee of Arrangement who had displayed them. The specimens are generally of the kind sold by the best makers and retailers, and show great perfection in this department of the arts. When all the specimens are so good, distinction becomes very difficult, and the Committee have in general been guided in their awards by the improvement manifested over articles formerly exhibited, or by the novelty of the articles.

To G. & D. N. Ropes, of Portland, Maine, for knives and forks of beautiful finish. (No. 295 and 300.) A Silver Medal.

To Leonard Reed & Barton, of Taunton, Massachusetts, for specimens of Britannia ware, deposited by S. D. Hastings, and Krug & Colladay. (No. 800.) A Silver Medal.

To J. Rittenhouse, of Germantown, for coffee mills, with very little friction, and beautifully finished. (No. 194.) A Silver Medal.

To Joseph Lingard, of Philadelphia, for samples of gun locks, a new article. (No. 751.) A Silver Medal.

To R. Heinisch, of Newark, N. J., for tailors' shears, improved since the last exhibition, deposited by Charles Harkness. (No. 584.)
A Silver Medal.

To Thomas Cooke, of Norwalk, Connecticut, for door knobs of woods of different colours. (No. 672.) A Certificate of Honourable Mention.

To Luther Fox, of Taunton, Massachusetts, for his carpenters' planes, deposited by B. Horner. (No. 531.)
A Certificate of Honourable Mention.

To the New Hope Lock Manufacturing Company, for the specimens of

Ball's lock without springs, deposited by Charles Carpenter. (No. 650.)
A Certificate of Honourable Mention.

As this lock is supposed to be upon a new principle, it is referred for particular examination to the Committee on Science and the Arts.

To the New England Screw Company, for specimens of wood screws, deposited by Carr & Keim, a cheap and good article.
A Certificate of Honourable Mention.

To William Rowland, of Philadelphia, for his saws, showing their usual excellence. (No. 155.) A Certificate of Honourable Mention.

To William and Charles Johnson, of Philadelphia, for a collection of admirably finished saws and Carpenters' tools. (No. 124.)
A Certificate of Honourable Mention.

To J. Russell & Co., of Greenfield, Massachusetts, for chisels and knives, well finished, deposited by Curtis & Hand. (No. 712.)
A Certificate of Honourable Mention.

To J. Paul, of Philadelphia, for edge tools. (No. 206.)
A Certificate of Honourable Mention.

These beautiful tools are understood to have been finished for the exhibition.

To Augustus Prutzman, of Philadelphia, for his door locks of ingenious construction and beautiful finish. A Certificate of Honourable Mention.

To J. Sloat of New York, for good specimens of screw traps, deposited by Carr & Keim. (No. 309.) A Certificate of Honourable Mention.

To the Douglass Manufacturing Company, of Massachusetts, for their edge tools, deposited by Collins & Brothers. (No. 683.)
A Certificate of Honourable Mention.

To the Taunton Manufacturing Company, of New Jersey, for their edge tools, deposited by Livingston & Lyman. (No. 462.)
A Certificate of Honourable Mention.

To James Williams, Camden, N. J., for specimens of edge tools, deposited by R. Lesley, of Philadelphia. A Certificate of Honourable Mention.

These tools were probably the most highly finished presented for exhibition, but as no evidence was presented that they were not prepared for this purpose, the Committee could not make a higher award.

To Thomas Wildes, of New York, for specimens of Britannia ware, deposited by S. D. Hastings. (No. 635.)
A Certificate of Honourable Mention.

To Thomas Loring, of Philadelphia, for plated cast iron andirons, a beautiful article. A Certificate of Honourable Mention.

To E. W. Bushnell, of Philadelphia, for tools for carpenters, and for skates. (No. 522.) A Certificate of Honourable Mention.

Richardson's eccentric door springs, (No. 286.) are referred for examination to the Committee on Science and the Arts.

The articles manufactured by W. H. Carr, and deposited by Carr & Keim, consisting of hay and manure forks, &c., were very creditable; but as Mr. Carr is a member of the Board of Managers, are passed over without special notice.

Leather and Manufactures of Leather.

The Committee have made the following awards in this department:

To Samuel A. Hagner, of Philadelphia, for a very light and neat set of single harness. A Certificate of Honourable Mention.

To William Morris, of Philadelphia, for a set of single harness of similar quality. A Certificate of Honourable Mention.

To W. N. Lacy, of Philadelphia, for a set of coach harness.
A Certificate of Honourable Mention.

To Charles L. Pascal, of Philadelphia, for a military saddle.
A Certificate of Honourable Mention.

To E. Pearce, of Philadelphia, for a sulky bridle, rounded without a seam. A Certificate of Honourable Mention.

To T. Moyer & Son, of Philadelphia, for various specimens of saddles, of excellent workmanship. A Certificate of Honourable Mention.

To Alexander L. Hickey, of Philadelphia, for traveling trunks, ingeniously contrived and well made.
A Certificate of Honourable Mention.

To Daniel McGovern, for a pair of leather coach collars.
A Certificate of Honourable Mention.

To James E. Brown, for a leather traveling trunk.
A Certificate of Honourable Mention.

To Pearson & Sallada, of Philadelphia, for specimens of riding whips.
A Certificate of Honourable Mention.

To Mahlon Warne, of Philadelphia, for specimens of covered buckles, superior to the best imported. A Certificate of Honourable Mention.

To McConnell & Avery, of Boston, Massachusetts, for specimens of japanned leather. A Certificate of Honourable Mention.

To A. & J. Peterson, for two very large well tanned hog skins for saddle seats. A Certificate of Honourable Mention.

To E. W. Walker, of Pawtucket, Rhode Island, for specimens of sheep and calf skins, for printers' rollers, &c.
A Certificate of Honourable Mention.

To Kinsey & Taylor, for specimens of Morocco leather.
A Certificate of Honourable Mention.

To Hummel & Son, for well prepared goat and buck skins, fancy colours.
A Certificate of Honourable Mention.

To Aymer & Fritz, for goat skins, or French morocco, dressed with and without oil, excellent articles. A Certificate of Honourable Mention.

To John Lippincott, for chaise-top, lining, and bag hides, of excellent finish. A Certificate of Honourable Mention.

To Scattergood & Boustead, for a calf skin dressed on the grain.
A Certificate of Honourable Mention.

The last named article being supposed to present an improvement where leather is used for boots and shoes, has been referred for examination to the Committee on Science and the Arts.

Stoves and Grates.

The variety of articles under this head, for parlour or kitchen use, was very considerable, and many of the latter kind were repeatedly under trial during the exhibition. In accordance with the remarks of the judges, the Committee awards:

To J. W. Kirk & Co., of Philadelphia, for their improved cooking stove.
A Silver Medal.

To Isaac Ten Eyck, of Philadelphia, for a stove for cooking with wood.
A Certificate of Honourable Mention.

To J. J. Hess, of Philadelphia, for his cooking stove.
A Certificate of Honourable Mention.

To H. H. Stimpson, of Boston, Massachusetts, for a cooking range.
A Certificate of Honourable Mention.

To Samuel Lloyd, for his improved Barrows' cooking range.
A Certificate of Honourable Mention.

To Samuel R. Andrews, of Philadelphia, for a cooking range for the use of a large family. A Certificate of Honourable Mention.

To Weaver & Volkmaar, of Philadelphia, for No. 580, a parlour stove of superior workmanship. A Certificate of Honourable Mention.

To Morris, Tasker & Morris, for a polished cast iron grate of superior workmanship. A Certificate of Honourable Mention.

The judges remark that the bars of the grates in the radiating stoves are too far apart to allow of the use of nut coal, which they consider a defect in their construction.

To Sherman & Co of North Marshfield, Mass., for rivets for sheet iron work, deposited by Harned & Elliott, a superior article to the imported.
A Certificate of Honourable Mention.

Models and Machinery.

The specimens of models and machinery were probably more varied and interesting than those of any other branch of the exhibition; the advance which they display over former exhibitions, is deserving of special notice, and commendation. The Committee have divided the articles into two classes, one of which being presented on account of perfection in workmanship, were considered as particularly competing for the awards at the exhibition, and others consisting of new inventions and ingenious combinations, requiring close, and deliberate examination—they have referred to the Committee on Science and the Arts, who are empowered to bestow the Scott's Legacy Premiums and Medals. A few of the more simple models, and of which the novelty was well ascertained, have been classed with the first mentioned articles. Many of the specimens of good workmanship were exhibited by Managers of the Institute, and although the result is gratifying to the institution, yet they are, of course, excluded from more than a mere mention. The following awards are made to the best articles exhibited:

To the High Street Machine Company, of Providence, Rhode Island, for a scroll or spiral chuck, deposited by D. W. Henderson, which has been approved as a convenient and useful tool. A Silver Medal.

To J. H. Stewart, of Philadelphia, for a fly press for printing cards, deposited by Thomas F. Adams, and used by him for printing during the exhibition. A Certificate of Honourable Mention.

To Marshall & Brock, of Philadelphia, for a slide lathe for heavy turning, deposited by Louis Lebanday.
A Certificate of Honourable Mention.

To Nicholas Wall, of Philadelphia, for a slide lathe for heavy turning, deposited by the maker. A Certificate of Honourable Mention.

To Philip Garrett, jr., for a neat and well finished foot lathe.
A Certificate of Honourable Mention.

To Jacob Lodge, of Philadelphia, for a very simple geared foot lathe.
A Certificate of Honourable Mention.

To Adam Ramage of Philadelphia, for a very simple copying printing press with a wrought iron frame.
A Certificate of Honourable Mention.

To W. M. Hartshorne, of Philadelphia, for a heavy punching machine, and a screw for a slide lathe. A Certificate of Honourable Mention.

To George Ruhl, of Philadelphia, for a hose carriage made for the Columbia Hose Company, a beautifully finished article.
A Certificate of Honourable Mention.

The axles by T. & M. Greer, are said to present novelty in arrangement, but the attention of the judges was not called to this fact in time to allow of an examination.

The following articles have been referred to the Committee on Science and the Arts, and the models will be retained by the Actuary, and an examination made of them, unless the depositors or owners desire to withdraw them.

A machine for cutting sole leather, by Jonathan Whipple, of Grafton, Massachusetts, deposited by Boustead & Shoemaker.

A model of an overshot wheel, by Robbins and Ashby of Bordentown, New Jersey, deposited by Rudolph Justice.

Models of improved lattice bridges, by Hermann Houpt, C. E., deposited by Thomas J. Houpt.

An engine for cutting the teeth of spur, bevel or crown gear, by W. M. Hartshorne of Philadelphia.

A machine for cutting circular plates from tin, by Andrew Tracy, of Poughkeepsie, New York.

A fire engine by Joel Bates of Philadelphia.

A model of an apparatus for supplying water to boilers, by B. M. Hyatt, of Wilmington, Delaware.

A machine for cutting the round tenons of spokes for wheels, by Mahlon Grigg, of Camden, New Jersey.

A machine for making the material of hat bodies, and the hat bodies, by H. S. Miller of Philadelphia.

Models of several machines already reported upon favourably by the Committee on Science and the Arts, were presented to the public, such as Naglee's turn-out for railroads; Schofield's water wheel governor; E. Bancroft's machine for straightening heavy-wrought iron bars, Isaac Babbit's soft metal boxes, for railway car axles, and others. A model of a caisson intended for laying the foundation of the light-house to be erected on the Brandywine shoal, by Major Bache, of the corps of topographical engineers, attracted considerable attention.

The Committee of judges speak in terms of the highest commendation of the heavy machinery made for the Government steam vessel, by Merrick & Towne, of Philadelphia. The main pedestals, of three tons in weight, they say, as "castings, have never been excelled in this country," and the wrought iron work they consider as alike deserving of high commendation. The accuracy of the joints in the work of the side links, rivals the best work usually put upon the British steam engines. The brass work of the gauge cocks, &c., is spoken of in like terms of high commendation. The castings for the brass work were made by John Agnew, of Philadelphia.

The Committee award a Certificate of Honourable Mention, to Charles Piggott, for moulding the main pedestals, and a Certificate of Honourable Mention to John Newsham, for forging the socket end of a bolt for holding down the pedestal.—Both of the above named young men are apprentices of Merrick & Towne and the articles are those just referred to.

Wire.

To Brown & Elton, of Waterbury, Connecticut, for a lot of copper and brass wire, deposited by Krug & Colladay.

A Certificate of Honourable Mention.

Plumbers' Work.

The specimens of lead pipes from one quarter inch to four inches in bore, intended for gas and water pipes, were all made by a particular process which the American patentee wishes to have examined by the Committee on Science and the Arts, to whom it has been accordingly referred. For the workmanship of these specimens the Committee award to Tatham & Brothers of Philadelphia. A Silver Medal.

Cabinet Ware.

This department was by no means as rich as usual in specimens; the forms of the articles exhibited do not appear to have improved, and though the workmanship of many was creditable, the judges were of opinion that no premium should be awarded. They recommend the following honorary mentions:

To John P. Seidel, of Philadelphia, for a well made lady's work table.

A Certificate of Honourable Mention.

To Moore & Campion of Philadelphia, for a wardrobe.

A Certificate of Honourable Mention.

To Crawford Riddell, of Philadelphia, for a secretary.

A Certificate of Honourable mention.

To J. & A. Crout, for a sofa of American wood.

A Certificate of Honourable Mention.

Musical Instruments.

The report of the judges on this subject is one of the most elaborate which has been presented to the Committee, and great pains were taken in examining the claims of different competitors. The following awards were made according to the recommendation of the judges, whose report will be published for reference.

To Brown & Hallett, of Boston, Massachusetts, for a six octave piano, of superior tone, and with a peculiar arrangement of the soft pedal, deposited by L. Meignen & Co. A Silver Medal.

To the New York Manufacturing Company, for a six and a half octave piano, deposited by William Swift, ranking next, and close to, the foregoing in the opinion of the judges. A Certificate of Honourable Mention.

To Thomas Loud, of Philadelphia, for a six and a half octave piano, of excellent touch and brilliant tone.

A Certificate of Honourable Mention.

To J. Pfaff, of Philadelphia, for flutes made by him.
A Certificate of Honourable Mention.

To O. M. Coleman, of Philadelphia, for his æolian lute.
A Certificate of Honourable Mention.

Glass Ware.

The display of glass ware has been excelled in beauty by former exhibitions, but the improvement in moulded glass has in no case appeared so strongly as on the present occasion. For common use this article has the recommendations of economy combined with considerable beauty of appearance; while it can be purchased for less than half the price of similar cut glass, a close examination is required to perceive that it has been moulded. The articles cut from moulded glass were also excellent, and are much cheaper than those technically known as cut glass.

To the New England Glass Company, for lot No. 350, of cut and moulded glass, deposited by S. D. Hastings, and for two cut glass decanters, deposited by W. M. Muzzey.
A Silver Medal.

To the Union Glass Company, of Philadelphia, for wine glasses cut over moulded glass. A Certificate of Honourable Mention.

To Coffin & Hay, of Winslow, New Jersey, for two glass shades for flowers. A Certificate of Honourable Mention.

This article has a slightly greenish tinge, which no doubt may be avoided; the shape is good, and the whole effort successful.

Books and Stationary.

The stationery exhibited presented an admirable view of the state of this branch of manufacture, so highly creditable to the United States. The Committee do not find, however, that any striking improvement has been made in this department in general since the last exhibitions, though some particular branches have advanced. The following awards are made:

To Thomas F. Adams, of Philadelphia, for his single and double enamelled visiting cards. A Silver Medal.

The beauty of the finish of these cards has never been exceeded; the glazed surface is not liable to scale, and it is said that the whitening material is different from that generally used, and the cards less exposed to darken by exposure to the air. They take an excellent impression from common types which are used in Mr. Adams' mode of printing.

To R. & A. H. Hubbard, of Norwich, Connecticut, for the improvement in the manufacture of blotting paper and of coloured printing paper, specimens of which were deposited by C. & W. H. Magarge.
A Silver Medal.

To A. C. & W. Curtis, Newton, Mass., for printing paper, of excellent quality, deposited by C. & W. H. Magarge.
A Certificate of Honourable Mention.

To C. & W. H. Magarge, of Philadelphia, for a specimen of wall paper, equal to the French article. A Certificate of Honourable Mention.

To Tileston & Hollingsworth, of Milton, Mass., for specimens of plate paper, of great beauty, deposited by C. & W. H. Magarge.
A Certificate of Honourable Mention.

To C. Sherman & Co., for a beautiful specimen of typography, (a copy of Lalla Rookh.) A Certificate of Honourable Mention.

To John H. Dohnert, for a great variety of marbled papers of good quality. A Certificate of Honourable Mention.

To S. C. & E. Mann, of Dedham, Massachusetts, for their marbled papers. A Certificate of Honourable Mention.

Various qualities of letter and writing papers from the manufactories of Jessup & Brothers, of Westfield, Massachusetts, Owen & Hurlbut, South Lee, Mass., H. & E. Goodwin, of Hartford, Connecticut, R. & A. H. Hubbard, of Norwich, Connecticut, D. & J. Ames, of Springfield, Massachusetts, Amies of Dove Mills, Montgomery county, Pa., and the Southworth Manufacturing Company, were exhibited, and in reference to prices, colour, uniformity, glazing, &c., merited high commendation.

To Crehore & Neal, for coloured tissue papers, deposited by C. & W. H. Magarge. A Certificate of Honourable Mention.

To John B. Kreymborg, Jr., for an assortment of quills, of very even quality. A Certificate of Honourable Mention.

The uniformity in the selection of his quills is said to characterize the articles of this young manufacturer.

Maps and Charts.

The principal contribution in this department was from H. Tanner, Jr., but two beautiful specimens of topographical work by Major H. Bache and Major James D. Graham, of the United States Topographical Engineers, were also deposited by one of the members of the Institute, and met with high commendation from those who are judges of such work. A map for the blind, by Dr. Rose, of the Pennsylvania Institute for the Instruction of the Blind, which has received the award of a Scott's Legacy Medal, was also exhibited.

The Committee awards:

To H. Tanner, Jr., of Philadelphia, for a variety of maps deposited by him. A Certificate of Honourable Mention.

To F. J. Roberts of Philadelphia, for a well executed map of Philadelphia. A Certificate of Honourable Mention.

Paper Hangings.

No department of the arts represented at the exhibition has made more progress than this, and the beauty of the specimens struck many persons with surprise. The following awards have been made.

To Howell & Brothers, of Philadelphia, for the excellence of the workmanship and variety of the paper hangings exhibited by them. A Silver Medal.

To John Beaty, for the specimens of paper hangings, especially the patterns in bronze and velvet. A Certificate of Honourable Mention.

To Finn & Newland, for the paper hangings exhibited by them. A Certificate of Honourable Mention.

To Charles Longstreth, for similar specimens. A Certificate of Honourable Mention.

Fine Arts.

The report of the judges on the Fine Arts was received at so late a date

as to render it impossible to include their notices of the articles submitted to them at the public reading of the report of the Committee on premiums and exhibitions. In conformity with what appears to be the rank assigned by the judges to the different productions exhibited, the following awards are made:

To J. T. Bowen, of Philadelphia, for No. 458, specimens of lithography, "uncommonly fine and reflecting credit on American arts."
A Certificate of Honourable Mention.

To Francis Humphries, of Philadelphia, for No. 103, "beautiful vignettes." A Certificate of Honourable Mention.

To Draper, Toppan, & Co., of Philadelphia, for No. 419, beautiful spemens of bank note engravings. A Certificate of Honourable Mention.

To Wm. Humphries, of Philadelphia, for No. 687, a capital line engraving. A Certificate of Honourable Mention.

To Joseph E. Parker, of Philadelphia, for his specimens of heliography. A Certificate of Honourable Mention.

The judges mention with approbation, No. 62, a portrait of Gov. Porter, by J. M. De França; No. 82, a portrait of a lady, by T. B. Welch; No. 101, a portrait of a lady, by J. L. Jahraus; No. 105 and 109, sketches for cottages, by J. Skirving; No. 134, a crayon drawing of drapery, by Geo. G. Heiss; No. 156, a mezzotint, by J. Sartain; No. 475, a sketch in body colour, by J. R Smith Jr.; No. 484, oil paintings, by J. A. Woodside; No. 83, an engraving by T. B. Welch.

The Committee further award to John Gibson, of Philadelphia, for his specimens of Graining (No. 479.) A Silver Medal.

Silver Ware and Plated Goods.

These branches of the arts have attained great perfection in our country; so much so that any quality of workmanship may be obtained which is desired. The specimens at the exhibition were not numerous, but were generally admired. The following awards are made:

To Bard & Lamont, for a highly finished tea set, pitchers, &c.
A Certificate of Honourable Mention.

To R. & W. Wilson for a tea set and pitcher, richly chased.
A Certificate of Honourable Mention.

To Benjamin C. Lotier, for a rich specimen of chasing, executed by himself. A Certificate of Honourable Mention.

To Taylor & Baldwin, of Newark, N. J., for a beautiful specimen of gold filagree work. A Certificate of Honourable Mention.

The Committee also awards, as a mark of encouragement,

To Henry Butler, an apprentice of Jacob Bennett, for two pairs of salt stands. A Certificate of Honourable Mention.

To Anthony Morris, an apprentice, for specimens of chasings in brass.
A Certificate of Honourable Mention.

Book Binders' Work and Tools.

This is one of the most improved departments of the exhibition, and one that has excited very general attention. Some of the specimens of binding were prepared for the exhibition, but most of them were not so prepared.

The beauty of the muslin binding, and the richness and good taste of its gilding, deserve high praise from the Committee. The following awards have been made:

To R. Lindsay & Co., of Philadelphia, for No. 40, specimens of binding, deemed the best hitherto exhibited in this city, from the current productions of the bindery. A Silver Medal.

To Gaskill & Copper, of Philadelphia, for the best specimens of bookbinders' stamps. A Silver Medal.

In regard to the last named specimens, the Committee deem them worthy of the highest commendation, and consider that the work shown in this department is quite on a par with the best English specimens.

To Samuel Moore, of Philadelphia, for the best bound single volume, prepared for the exhibition. A Certificate of Honourable Mention.

To Abel & Pomeroy, of Philadelphia, for various specimens of binding of very good finish. A Certificate of Honourable Mention.

To A. C. Morin of Philadelphia, for engraved steel plates for embossing. A Certificate of Honourable Mention.

Marble and Statuary.

The following awards have been made upon the report of the judges:

To Messrs. Lees & Bradley, of Philadelphia, for a marble mantel, with well executed foliage. A Certificate of Honourable Mention.

To Jesse D. Claypole, of Philadelphia, an apprentice, for a copy of Canova's sleeping lion. A Certificate of Honourable Mention.

To Theodore Hess, of Philadelphia, an apprentice, for a box of polished marble. A Certificate of Honourable Mention.

To Augustus Brookfield, "aged fourteen years," for a miniature monument. A Certificate of Honourable Mention.

The Committee take great pleasure in following out the policy of the Franklin Institute in encouraging youthful aspirants, by suitable marks of attention to their specimens. They must, of course, view these certificates of honourable mention as offered in the spirit of encouragement.

The best specimen of marble work in the exhibition was the cornice forming part of the monument to General Mercer, from the marble yard of John Struthers & Son ; but as Mr. Struthers is a member of the Board of Managers, no award can be made for this article. The Committee also passes over the mantels deposited by William Struthers, though highly commended by the judges, because he is one of the partners in a firm the elder member of which belongs to the Board of Managers of the Institute.

To Kelly & Farley, for their scagliola pedestals. A Certificate of Honourable Mention.

The beautiful statue of the Fisherman's Daughter, by Pettrich, was entered by the liberal owner, General Keim, of Berks, only at the close of the exhibition; the well established reputation of the sculptor, and the public estimation of this particular work, render this a matter of less moment.

Hats and Caps.

At no previous exhibition has there been a display of articles in this branch equal to the one recently presented. The style, finish, and trimming, of the hats and caps, show much improvement. Some of the hats deposited

were made entirely and finished by the depositors, and others finished merely, and the Committee have been guided in their awards by that fact. They have awarded,

To Charles Oakford, for a case of hats, manufactured and finished by him, and of excellent workmanship. A Silver Medal.

To E. Kimber, Jr., for a case of substantial hats, made and finished by him. A Certificate of Honourable Mention.

To Mr. John Simpson, for a case of military and other hats and caps. A Certificate of Honourable Mention.

To S. H. Hare, for the hats and caps deposited by him. A Certificate of Honourable Mention.

To Charles Bulkley, for the hats and caps deposited by him. A Certificate of Honourable Mention.

The hats deposited by Thomas Evans & Co., by Bird Brothers, by C. C. Raphun, by Edward Damai, by Woodruff & Kester, by Oliver Brooks, and by S. D. Walton, were creditable specimens. The otter cap by Oliver Thacher, was also well got up.

Combs and Brushes.

There were not very many specimens of this manufacture, but those presented were highly creditable. The judges particularly notice the following, to which awards are made:

To G. W. Morris, for his blending brushes, a new article. A Certificate of Honourable Mention.

To S. Winner, of Philadelphia, for No. 80, deposited by maker, for one card of tortoiseshell combs. A Certificate of Honourable Mention.

To M. Busch, of Philadelphia, for one case and six cards of brushes. A Certificate of Honourable Mention.

To the pupils of the Pennsylvania Institution for the Instruction of the Blind, for specimens of brushes manufactured by them. A Certificate of Honourable Mention.

Coach Work.

To Ogle & Watson, for excellent specimens of coach work. A Certificate of Honourable Mention.

Boots and Shoes.

The number of specimens in this branch was small, and though it included some good work, the Committee does not feel warranted in making any special awards.

Chemicals.

The collection of chemicals was creditable, showing decided progress in the number, as well as the quality, of articles now manufactured. In reference to those which were deposited in time for competition, the following awards have been made. Remarks upon the colours exhibited, will be found under another head.

To Farr & Kunzie, for specimens of sulphate of quinine, nitrate of silver, red precipitate, and corrosive sublimate, deposited by them. A Certificate of Honourable Mention.

To Smith & Hodgson, for the biniodide of mercury, and narcotine, deposited by them. A Certificate of Honourable Mention.

To Wetherill & Brothers, for the red precipitate and calomel deposited by them. A Certificate of Honourable Mention.

To Campbell Morfit, for specimens of piperine, benzoic acid, tannin, sulphate of morphia, phosphate of soda, and iodide of potassium.
A Certificate of Honourable Mention.

The crystals of alum, by N. Lennig, & Co., the phloridzine, by Richard Price & Co., were particularly commended by the judges, as also the putting up of the Siedlitz powders of Merrick & Haskell.

To A. Gölsh, for his friction matches without sulphur.
A Certificate of Honourable Mention.

Philosophical Apparatus.

The number of these articles was increased beyond that of former exhibitions, and a general improvement was shown in those deposited. The Committee regretted to see no specimens of surveyors' and engineers' instruments, for the making of which our city enjoys a deserved reputation. The Committee recommended the following awards:

To Alva Mason, of Philadelphia, for an electrical machine, air pump, mechanical powers, &c., deposited by him.
A Certificate of Honourable Mention.

To D. Davis, Jr., of Boston, for various articles of magneto-electric apparatus, quite equal to those of the same kind from London.
A Certificate of Honourable Mention.

To Stephen Heintz, for areometers and thermometers, made by him.
A Certificate of Honourable Mention.

To W. G. Mason, for various specimens of medals, and a copy of an engraved plate, by the electrotype process.
A Certificate of Honourable Mention.

To George W. Hollingsworth, of Philadelphia, for his steel rulers and triangles, plain and wriggled. A Certificate of Honourable Mention.

As this is a desirable article for engineers, the Committee makes the above award, mentioning at the same time that very great exactness should be aimed at in instruments of this character, greater than has been attained in some of these articles.

The Newtonian telescopes, deposited by Messrs. Parkerson & Forten, could not be examined during the exhibition, without withdrawing them from the inspection of the public; it was intended to have done this on one of the last days of the exhibition, had the weather proved suitable; as this has not been the case, the instruments are referred for examination to the Committee on Science and the Arts.

Surgical Instruments.

The judges recommend and the Committee has made the following awards:

To Pugh Madeira, of Philadelphia, for a case of dental instruments, made for Messrs. Chiles & Birkey. A Silver Medal.

To H. Habermehl, for his operating table for dentists' tools.
A Certificate of Honourable Mention.

To Horatio G. Kern, for his dental instruments.
A Certificate of Honourable Mention.

To S. W. Stockton, for specimens of single artificial teeth, for setting.
A Certificate of Honourable Mention.

To H. S. Burr, for specimens of artificial teeth.
A Certificate of Honourable Mention.

The judges were of opinion that the best single artificial teeth, were by Mr. S. W. Stockton, and the best of those in sets and blocks, by H. S. Burr; in regard to the latter they remark that they exhibit a gradation of colour towards the points, and a translucency which distinguish them from all other specimens of artificial teeth that have fallen under the observation of the Committee.

Copper and Brass.

The articles of copper and brass manifested much improvement in this branch of the arts. The Committee awards,

To L. Debozear, of Philadelphia, for a bell, of rich tone, and good figure and proportions. A Silver Medal.

To Isaac Babbitt, of Boston, for a set of brass castings, the best which have come under the notice of the Committee. A Silver Medal.

To Joseph Oat, of Philadelphia, for tubes for the boilers of locomotive engines. A Certificate of Honourable Mention.

To Hill & Chamberlain, of Boston, for a similar article.
A Certificate of Honourable Mention.

To John McDavitt, of Philadelphia, for a copper tea kettle.
A Certificate of Honourable Mention.

Japanned Work.

The specimens of Japan ware exhibited were of beautiful workmanship, quite equal to those imported, and the Committee awards,

To Daniel Dick, of Philadelphia, for specimens of tea-trays and grocers' canisters of Japan ware. A Silver Medal.

Plated and Steel Saddlery.

The contributions in this department were few in number. The Committee awards,

To C. W. Ingram, of Philadelphia, for his bits and other saddlery,
A Certificate of Honourable Mention.

Guns.

The guns presented were of great merit. The judges, after a critical examination and trial of their merits, decline making any distinctions, and recommend the following awards, which are confirmed by the Committee:

To J. Krider, of Philadelphia, for three rifles, deposited by him.
A Certificate of Honourable Mention.

To William Robinson, of Philadelphia, for a rifle, a rifle and shot gun, and a double barrelled shot gun. A Certificate of Honourable Mention.

To D. Schwarzwälder, of Philadelphia, for a rifle and shot gun.
A Certificate of Honourable Mention.

To Hazeltine & Cumming, of Philadelphia, for a rifle, exhibited by them.
A Certificate of Honourable Mention.

To Tryon, Son & Co., of Philadelphia, for a rifle, deposited by them.
A Certificate of Honourable Mention.

To Jacob Koonz, of Philadelphia, for a rifle and traveler's gun.
A Certificate of Honourable Mention.

The revolving-chamber pistol, by Colt, was not in order, and could not, therefore, be specially examined.

Paints and Colours, Enamels and Stained Glass.

The difficulty of deciding correctly of the relative merits of colours by such trials as can be made at an exhibition, has induced the judges to abstain from speaking positively in reference to many of them. The Committee accordingly awards,

To Wetherill & Brother, for specimens, No. 166, of white lead, Prussian blue, and chrome yellow. A Certificate of Honourable Mention.

To Jewett & Sons, Brooklyn, N. Y., for lot No. 754, white lead, dry and ground in oil. A Certificate of Honourable Mention.

To Charles J. Crease, of Philadelphia, for specimens of chrome green.
A Certificate of Honourable Mention.

The varnishes by Wm. M. Humes and by Clemens & Baker were commended by the judges.

To T. Thomas, of New York, for specimens of stained, coloured, and painted glass, parts of which are the best yet exhibited.
A Silver Medal.

To Edwin Bishop, for specimens of enameling, the materials of which are of American manufacture. A Silver Medal.

Of these articles the judges remark, that "the stained glass deserves high commendation, from the variety, brilliancy, and transparency of the tints, and from the fine execution of one of the sketches, resembling an India ink sketch. The Committee believes part of these specimens to be superior to any which have been exhibited in this city, and deserving of especial notice."

"The specimens of enameling are remarkably beautiful in colour, execution, and finish of the glaze, and as every material employed in them is made in this country and city, by a citizen, and as the finished article can be produced at lower rates than the imported, it is believed that more than a mere commendation should be awarded."

Fancy Articles.

The miscellaneous character of the articles grouped under this head, makes the task of discrimination much more difficult than in the case of many more important departments of the exhibition; and the Committee are much obliged by the attention of the gentlemen who have been appointed as judges. In the opinion of these gentlemen, this department sustains the same character which it had on former occasions; they remark, however, that "a small number of articles have been admitted which ought to have been excluded, on account of their trivial and commonplace character, their faulty, and tasteless design, or imperfect workmanship." They go on to say, that they "do not refer to the works of children, for which every allowance ought to be made, but to the crude or hasty labours of tyros in the arts."

The following awards are made, in conformity with the report of the judges:

To J. S. Little, of Philadelphia, for Nos. 88 and 121, garden vases and ornamental work of artificial stone. A Silver Medal.

The forms of the dogs, vases, &c., were much admired, and certificates of durability under exposure to the weather for several years, were submitted from satisfactory sources.

To E. Kirk, of Philadelphia, for No. 326, highly improved anthracite ware. A Certificate of Honourable Mention.

The judges observe, that "Mr. Kirk has been engaged in this manufacture for about five years, and deserves great praise for his perseverance under so many difficulties." They consider that the improvement in the forms of the ware might still be carried further.

To John Thornly, of Philadelphia, for No. 225, a variety of India rubber shoes. A Certificate of Honourable Mention.

To J. L. Ripley, of Philadelphia, for No. 231, specimens of similar articles. A Certificate of Honourable Mention.

These articles consist of socks, over-shoes, shoes plated with gum, life-preservers, &c. They were well made, and certificates of durability, satisfactory to the judges, were laid before them.

To T. B. Smith, of Philadelphia, No. 27, for various assorted pickles, &c., of excellent flavour and good appearance.
A Certificate of Honourable Mention.

To C. D. Baker, of Philadelphia, for specimens of martinoes, No. 725, pronounced of good quality.

To Mrs. Hall, of Philadelphia, for No. 162, a piano cover, embroidered on cloth, a very beautiful article. A Certificate of Honourable Mention.

To Mrs. J. C. Evans, of Philadelphia, for a box of artificial flowers, (No. 763,) considered by the judges to be the best in the exhibition.
A Certificate of Honourable Mention.

To Phoebe Ayres, Philadelphia, for a silk quilt, No. 247, deemed the best exhibited. A Certificate of Honourable Mention.

To S. W. Horn, Philadelphia; for seven vases of wax flowers and fruit, of beautiful execution. A Certificate of Honourable Mention.

The judges have also noticed with commendation,

A boat beautifully modeled and finished by George James, in which, however, they would "prefer a sharper or more concave bow, as better adapted to attain the maximum velocity."

A lot of brass-bound buckets, an umbrella stand, seives, and sundry other articles of housekeeping, of good finish, by Wm. Boyer and Wm. Bransby; Nos 476 and 477.

A model of the ship Pennsylvania, by Jos. O. Sawyer.

A frame of botanical specimens from the herbarium of Peter A. Browne, of Philadelphia, remarkable in general for the preservation of the colours of the plants.

A specimen of hemp from the aloe, from the American Colony at Liberia; deposited by Elliott Cresson, Philadelphia.

A specimen of worsted work, (Little Red Riding Hood,) by Mrs. Thos. Sergeant, Philadelphia; one of the two best specimens in the exhibition.

A specimen equal to the one just mentioned, but a different style and subject; No. 741, deposited by Dr. Chaloner.

Specimens of crape and silk flower work, (820) by Mary Ann Knecht, (774) Sarah Elsegood, (745) Mrs. J. Rapp, the relative excellence of which the judges could not determine.

Silk stocks (No. 185,) made by C. A. Walborn, Philadelphia, very light and elastic, and the workmanship good, but made of foreign material.

Fine corded linen collars (No. 377), made by Miss Mary Brown, "neater than any heretofore brought to this market."

In conclusion, the Committee beg leave to return thanks to those gentlemen who acted on the Committee of Arrangement, and to whom much credit is due for the display in their different departments; the labour performed by them is highly appreciated by the Franklin Institute, and, doubtless, also by the public. To those also of the judges who have favoured the Committee with their judgment on the articles examined by them, the Committee would also return their thanks. The Committee appends to its report some of the reports of the judges, which appeared particularly full, or in which the interest of the subject seemed to render the presentation of these details desirable to the public.

Progress of Practical and Theoretical Mechanics and Chemistry.

A new Process for making Gas for Illuminations from Bituminous Schist.

The utilization of bituminous schist is a subject of great importance, as promising to make this substance profitable. M. Selligue is the inventor of the process for distilling this mineral, and has works for the purpose on a large scale. His mines are in the department of Saone and Loire, between Autun and the Central Canal, his three works are at St. Leger-du-Bois, Canton of Epinal; Surmoulin, near Autun, and Igernay, Canton of Cardesse. In these works the schist is distilled in close retorts, they leave a residuum of carbonaceous matter, which may be used for disinfection or discolouration, but not yet made serviceable. The volatile products are oils consisting principally of different carburets of hydrogen, which are made available for profit. A great quantity of inflammable gases are also disengaged during the distillation, and are directed into the furnace and used as a combustible.

The schists of Autun are very variable in character, but all are rejected which afford less than six per cent. of oil on distillation, but those now used average ten per cent., it is not rare, however, to find as much as twenty or twenty-five per cent., some afford as much as half their weight of oleaginous products.

The composition of 100 parts of liquid bitumen is as follows:

Light oil of variable density from 0.766 to 0.810, used for gas	35.57
Oil of greater density susceptible of being used in lamps	25.85
Fatty matter containing 12 per cent. of *paraffine* - -	12.
Pitch or tar - - - - - - - - - - -	17.28
Residue - - - - - - - - - - -	9.3
	100

It has long been suspected that the olefiant gases derive their illuminating properties from the oleaginous vapours which accompany the generally

slightly carburetted hydrogen gas which always forms the base of these gases. M. Pelletan maintained this view in a paper read before the Academy in December, 1816, and it has been confirmed by M. Selligue. It has been, on the other hand, asserted and received as certain that oxidated carbonic gas is always injurious in illuminating gas, and that it diminishes the brilliancy of the flame by lowering its temperature, on account of the low degree of heat developed during its combustion. M. Selligue has, however, established the fallacy of this doctrine.

M. Selligue's process is as follows:—Three tubes, or retorts, situated vertically in a new and ingeniously constructed furnace, are heated red. The first and second contains charcoal, and as fast as the charcoal disappears it is replaced, which is every five hours. This carbon is for the purpose of effecting the decomposition of the water introduced into the first tube in a continued stream, and where it is converted into hydrogen gas, carbonic acid, and oxide of carbon. But as the production of carbonic acid is to be avoided, the gases produced by the first tube are conducted into the next, where they are exposed again to incandescent charcoal, by which means the carbonic acid first formed is converted into oxide of carbon. The furnace is so arranged that this tube is the hottest of the three, so as to favour the total decomposition of the carbonic acid.

The third tube is filled with iron chains, the use of which is to present a large incandescent metallic surface, capable of distributing caloric in an equal and rapid manner to the gases or vapours passing through. On the one side this tube receives the gases produced by the decomposition of the water in the two preceding tubes, and in the other a continued stream of *light schistose oil.* This light oil is decomposed into new products still more volatile, and passes with the gas into a refrigerator, which, by cooling down the products, causes some of them to reappear. The schistose oil is therefore not entirely gasified, but that which does not change into gaseous matter is preserved uninjured. What is very singular is that the links of the chain in the tube are never covered with any carbonaceous deposit. Thus while the shistose oil is evidently decomposed by heat during this operation, its decomposition is modified in a successful manner by its diffusion amid a large volume of gas, such as that produced from the decomposition of water, and which serves as a vehicle.

From the third tube is produced hydrogen and oxide of carbon, derived from the decomposition of the water, and the gases or vapours from the decomposition of the oil. By passing into the apparatus 20 gallons of water, and 25 of schistose oil, 50,000 gallons of gas fit for illumination are produced in twenty hours. The gas so produced requires no farther purification, having passed through a refrigerator where are deposited the nondecomposed oil, and steam from the water. From the refrigerator the gas passes into the gasometer.

M. Selligue's process and apparatus are represented as being so simple, as to be easily used in factories and private establishments, while the price of the gas so produced is low enough to be employed for lighting the streets. It has been proved by experiment not to deteriorate, but to improve at a distance from the gasometer; at five miles distance the flame was purer than when just issuing from the gasometer. When cooled down to 13°F. below zero, its illuminating power was not sensibly diminished. The gas is also free from sulphuretted compounds, and gives no unpleasant smell. The odour of coal gas, we may observe, however, is attributed by some chemists to vapour of naptha, and not to sulphur solely. As it does not act upon

metallic reflectors, M. Selligue is able to use these additions with great advantage, so much indeed that with a parabolic reflector one of his burners enables a middling size print to be read 80 yards off.

M. Selligue has set up gas apparatus at the Royal Printing House, and the Batignolles at Paris; at Dijon, and other cities, all of which work well.

We may observe that this process is on similar principles to that of the air light, in which air was decomposed and the oxygen burned with oily or bituminous matters, and in this case water is decomposed and the hydrogen similarly combined. Civ. Eng. & Arch. Jour.

Important Discovery in Metallurgy.

At a recent sitting of the *Academie des Sciences*, M. Becquerel read a paper relating to a most important discovery, namely, the application of the electro-chemical power to the art of metallurgy, especially as regards gold, silver, copper, and lead.

After a few preliminary remarks, explaining the various services which this force can render to natural sciences, to arts and manufactures, the learned academician alluded in particular to the refining of the precious metals; and it will be seen in the course of this analysis the great advantage he has derived from the new methods introduced by him into different branches of industry.

It will also be gratifying to learn, that one of the poorest departments of France possesses a gold, silver, and lead mine, and that the happy results already obtained hold out a still more flattering prospect. The following is an analysis of the memoir presented by M. Becquerel:—

The experiments relative to the application of the electro-chemical power to refining *(metallurgie)* of silver, copper, and lead, without the aid of quicksilver, and with little or no fuel, have been continued by M. Becquerel with constant success: his operations were conducted upon a large scale, and embraced considerable quantities of ores derived from Europe, Asia, and America. The object of these researches was, in the first place, the immediate separation *(reduction)* of the metals one from the other, and especially of silver and of lead from galena; this operation was effected with so much rapidity, that at the preparatory foundry, in Paris, four pounds weight of silver can now be drawn off in the metallic state from silver ore in the space of six hours; secondly, the preparation which the ore is to undergo, so as to render each metal capable of being withdrawn by the electric current. This preparation varies according to the nature of the ore, presents no obstacle when the silver is in the metallic state, or in the nature of a sulphate, as usually occurs in Mexico and Peru, but it becomes more complicated when the silver is mixed with other substances; the use of a small quantity of combustible matter is then indispensible in order to effect the roasting at a low temperature.

Ores are generally found in great quantities in those countries, but are for the most part abandoned, owing to the want of sufficient fuel for effecting their amalgamation, or to their being found at too great a distance from the sea to transport them to Europe, unless at an enormous expense.

In Columbia, where large masses of gold and silver ore are found mixed with zinc, the richest are sometimes exported to Europe to be fused, whilst the poorest and those of a medium quality are either rejected altogether or used to so little advantage that the mining companies lose by them. Exer-

tions are now in progress for introducing the new methods, which are equally applicable to amalgamation and to the electro-chemical process.

The silver ores which are most difficult of amalgamation are those which contain a large portion of copper and arsenic. Ores of this description are found in considerable quantity, especially in Chili, where the inhabitants frequently offer them to Europeans, by whom they are sometimes taken for ballast for want of freight, and without any certainty of turning them to advantage.

The great difficulty was to be able to treat these substances in Europe so as to obtain, in separate portions, and at little expense, all the silver, copper, and arsenic they contained. This problem has just been solved in a satisfactory manner, and so as to ensure immense advantages to new speculators, who will no longer have to contend with the obstacles met with by their predecessors.

On inquiring into the causes of the delay experienced in working the mines in America, it will be seen that the principal ones arise from the high price of quicksilver, and the great difficulty of draining the water by which the mines are inundated. This is not the case in Asia, in the Russian possessions, which are rich in mineral productions, and yield larger profits from day to day in consequence of the introduction of the improvements lately adopted in Europe for reducing metallic ores. In the silver mines of Altaie the expenses for extracting the ore, process of reduction, and of the establishment, do not amount to a quarter of the rough produce, although the ore in general is of slight tenacity. These advantages are owing to the moderate price of labour, the abundant supply of combustible matter, and other substances required in the fusing, and which are not to be had in America, especially in Mexico and the Cordilleras.

The electro-chemical process can be easily applied to the ores at Altaie; however, in countries where sufficient fuel is at hand, and salt cannot be procured, the fusing operation will be always preferred, except in cases of complex ores, which often exercise the ingenuity of metallurgists.

There are but few silver mines worked in Russia. The only ones of importance are those of Altaie, Nertchinsk, and those of the Caucasus and the Ural; but the great source of mineral riches in that kingdom consists principally of the gold and platina dust (sands), the washing of which engrosses the chief attention of the Government. This process, though methodically conducted, is very imperfect, for a large quantity of the gold contained in the sand is lost; the proceeds, however, are considerable; during the last year no less than 12,200lbs. were obtained, upwards of 800,000*l.* value.

The argentiferous and auriferous galenæ which have been subjected to the electro-chemical process are perfectly fit for the extraction of gold and silver by washing. This method requires that the ores should be pulverized and roasted so as to separate the metal from the pyrites and other compounds which detain it. The silver and lead being removed, the ore thus reduced to about half its weight, can be washed with the greatest facility, and one man can wash several hundred pounds per day. This method was tried with the galena (very argentiferous) discovered a few years since at St. Santin Cantalés, in the department of Cantal, and which yielded not more than 2¾ grains of gold in every 200lb. of ore, with 30 per cent. of lead. But, upon adopting the electro-chemical process, the same quantity of ore produced something more than three drachms of gold. From this important result it is supposed that the rocks in that part of the country are auriferous, as might also be inferred from the name of the place, Aurilac *(auri lacus.)*

Another great advantage of the electro-chemical method is, that it enables the metallurgist to separate those portions of ore which contain gold, silver, &c., from those which contain none.

M. Becquerel then alluded to the other uses to which electricity might be applied in the manufacuture of metals, especially in the art of gilding silver and copper, as also for taking impressions in copper of medals, bassi relievi, and engravings.

The learned academician concluded by observing that this new and highly important power was only in its infancy, and that it would be impossible to foresee the immense services it was likely to render to the arts. Ibid.

Great Steam Engine Factory.

In Fawcett & Co's Factory, at Liverpool, are the following engines now in hand at the works, and the three largest nearly completed:

1 pair of	540	horse power	for the "President."
1 do.	420	do.	the "United States."
1 do.	450	do.	a French man-of-war steam frigate.
1 do.	300	do.	H. M. S. "Medina."
1 do.	30	do.	the "Calcutta Steam-tug."*
1 do.	45	do.	a Government tender.†
1 single engine of	60-horse power,		for Australia.
1 do.	50	do.	for a French house.

The President's Engines.—These are the most remarkable for their size, and are really a stupendous piece of workmanship. They are already fixed up, and strike the visitor with astonishment. The castings, and all the workmanship, are of the first description, and the architectural design of the frame-work, and pillars, is highly ornamental, without any sacrifice to the requisite strength. As probably the most suitable to attain this desideratum, the Gothic style has been adopted. The massy clustered pillars are surmounted by the pointed and moulded arch to correspond. The diagonal stays and their open work are in keeping; and such is the height and imposing effect of the whole, that visiters generally remarked that it strikingly resembled a handsome Gothic chapel. The beams are beautiful castings, as are the cylinders, and both of immense size and weight. The polished iron and brass work is superb, and the whole furnishes a gratifying proof, at once, of the enterprise and ingenuity of the men of England. The following are some interesting statistics of this stupendous piece of machinery:

Diameter of cylinder, . . .	80 inches.
Stroke of engine, ...	7 feet 6 inches.
Weight of cylinders, . . .	11 tons.
Valve-cases, from	6 to 6½ tons.
Beams (4 in number,) upwards of .	5 tons each.
Condensers, about . . .	10 tons.
Gothic pillars, four pairs, each . .	11 tons, 7 cwt.
Diagonal stays, four in number, each .	4 tons.
Main, or paddle shaft, . . .	9 tons.
Two eduction pipes, each . .	18 cwt.
Boilers, each	30 tons.
Bed-plates, (two,) each in one casting,	15 tons.

The whole engines and boilers, with the water, will weigh about 510 tons.

* Now building in India.

† To run, it is said, between Dover and Calais.

The hoisting-tackle used in setting up these engines is well worthy of notice. On the principal, or lower beams, of the roof, which are of extraordinary strength, railways are fixed, upon which are traversed scaffolds, railed round, and each carrying a powerful winch. On these scaffolds are also railways, at right angles with those on the beams, so that, by moving the scaffolds and the winches, any spot of the building may be attained directly perpendicular to the article to be hoisted, which, by other movements, can be lowered to any given site.

The Engines of the United States.—These are precisely similar in construction to those of the President, differing only in being a little smaller. No detailed notice of them is therefore required. The cylinders are 73½ inches in diameter, and the power is the same as that of the Great Western—namely, 420. They are erected in the same shed, or building, containing those of the President, and have been equally admired.

Civ. Eng. and Arch. Jour.

Rolling and Compressing of Iron.

Our attention has been directed to a novel and clever invention, applicable to an important branch of our manufactures, in the rolling and compressing of iron, producing thereby what may fairly be termed the thread of machinery. The articles to which the process applies have hitherto been made at the place where the demand has arisen, and only according to the extent actually required, but from the vast and exclusive advantages possessed by this mode, a large concentrated demand must arise.

In the process of rolling iron, the inference, upon the first blush, would be that there is nothing new in the operation of passing iron through rollers; but in this instance there is, the patentee having accomplished that which some of our leading engineers have hitherto doubted to be possible, namely, the rolling of iron alternately round and square, or with any other form of angle upon the same bar. This is accomplished by cutting the rollers according to the form required, when the iron passing through them with great rapidity, to the extent of fifteen times in a minute, assumes with an unerring precision, the various forms required. A rapid stride is thus made in the economy of time and labour, as the iron thus produced is, as appertaining to machinery purposes, for, upon being cut into given lengths, for bolts, rivets, &c., you get the round shaft upon which to cut the thread, and that with the square shoulder, and nothing remains but to pass it through the ordeal of compression to form the head of any figure or dimension required.

The extensive and largely increasing manufacture of machinery will receive great advantages from the perfection and exactness so desirable in its construction, from the circumstance that the connecting thread, as it may be termed, being all formed by one eye, will be of that uniformity, equality, and strength, that perfection is attained, with a great saving of labour to the mechanic, who will consequently have little if any trouble in applying them to his various purposes.

In the compressing department, applicable to bolts and other articles too numerous to particularize, and which forms a second patent, the most important result is derived from the regular temperature of the iron during the operation. "To strike the iron while it is hot," is a maxim too well understood and appreciated to need further remark than this—that a perfect bolt is instantly formed by one heating of iron, whilst, during the ordinary operation, a large portion of the heat is lost, which has to be recovered

by a second or third application to the furnace, thereby destroying, in some degree, the toughness and natural quality of the article, whence unsoundness ensues.

When this invention comes fully before the public, there can be no doubt of its beneficial results, both to the proprietors and to the artisan generally, from the various uses to which it will be applicable, and the facility which it will give him in perfecting his operations, while, as in some other large manufacturing concerns, he will no longer be at the mercy of the operative for his supply. Railway Mag.

Experimental Researches into the Strength of Pillars of Cast Iron, and other materials. By Eaton Hodgkinson, Esq.

The author finds that in all long pillars of the same dimensions, the resistance to crushing by flexure is about three times greater when the ends of the pillars are flat, than when they are rounded. A long uniform cast-iron pillar, with its ends firmly fixed, whether by means of disks or otherwise, has the same power to resist breaking as a pillar of the same diameter, and half the length, with the ends rounded, or turned so that the force would pass through the axis. The strength of a pillar with one end round and the other flat, is the arithmetical mean between that of a pillar of the same dimensions with both ends round, and one with both ends flat. Some additional strength is given to a pillar by enlarging its diameter in the middle part.

The author next investigated the strength of long cast-iron pillars with relation to their diameter and length. He concludes that the index of the power of the diameter, to which the strength is proportional, is 3.736. He then proceeds to determine, by a comparison of experimental results, the inverse power of the length to which the strength of the pillar is proportional. The highest value of this power is 1.914, the lowest, 1.537, the mean of all the comparisons, 1.7117. He thus deduces, first, approximate empirical formulæ for the breaking weight of solid pillars, and then proceeds to deduce more correct methods of determining their strength.

Experiments on hollow pillars of cast-iron are then described, and formulæ representing the strength of such pillars are deduced from these experiments.

After giving some results of experiments still in progress for determining the power of cast-iron pillars to resist long-continued pressure, the author proceeds to determine, from his experiments, the strength of pillars of wrought-iron and timber, as dependent on their dimensions. The conclusion for wrought-iron is, that the strength varies inversely as the square of the pillar's length, and directly as the power 3.75 of its diameter, the latter being nearly indentical with the result obtained for cast-iron; for timber, the strength varies nearly as the fourth power of the side of the square forming the section of the pillar. Experiments for determining the relation of the strength to the length in pillars of timber, were not instituted, as, from the great flexure of the material, it was considered that no very satisfactory conclusions on this point could be derived experimentally.

L. & E. Philos. Mag.

A Mode of Bending Disks of Silvered Plate Glass into Concave or Convex Mirrors by means of the pressure of the Atmosphere. *By* MR. JAMES NASMYTH.

The difficulty of obtaining large specula for telescopes, together with the disadvantages attending the weight, the brittleness, and liability to oxidation, of the speculum metal generally used, induced Mr. Nasmyth to turn his attention to the employment of silvered plate glass for telescopic purposes, as it possesses perfect truth of surface, is lighter than metal, is not liable to oxidation, and a greater quantity of light is reflected from it than from any metallic surface.

To give a concave or convex form to a disk of plate glass, a certain pressure must be made to act equally over the surface. This equal pressure is obtained on Mr. Nasmyth's plan, by taking advantage of the weight of the atmosphere.

A disk of silvered plate glass, 39 inches in diameter and $\frac{3}{16}$ths of an inch in thickness, is fitted and cemented into a shallow cast-iron dish, turned true on its face so as to render the chamber behind the glass perfectly air tight; by means of a tube communicating with this chamber, any portion of air can be withdrawn or injected.

To produce a concave mirror so slight a power is required, that on applying the mouth to the tube and exhausting the chamber, the weight of the atmosphere, which amounts in this case to 3558lbs., acting with equal pressure over a surface of 1186 square inches, causes the glass to assume a concavity of nearly three-quarters of an inch, which, in a diameter of 39 inches, is far beyond what would ever be required for telescopic purposes. On re-admitting the air, the glass immediately recovers its plane surface, and on forcing in air with the power of the lungs, it assumes a degree of convexity nearly equal to its former concavity. The degree of concavity or convexity may be regulated to the greatest nicety, and it is proposed to render the degree of concavity constant by placing in the air-tight chamber a disk of iron turned to the required form, and allowing the pressure of the atmosphere to retain the glass in the form given to it by its close contact with the iron disk.

The curve naturally taken by the glass when under the pressure of the atmosphere is believed by Mr. Nasmyth to be the catenary, inasmuch as its section would be the same as that of a line suspended from each end, and loaded equally throughout its length.—*Trans. Inst. Civ. Eng.*

Mech. Mag.

Important Application of Electricity.

At a recent meeting of the Academy of Sciences at Paris, the following description was given by M. Becquerel, of an interesting voltaic experiment performed by himself, which exhibits in a striking manner how the intensity of electrical power is accumulated by the current passing through wires twisted spirally. A platinum wire placed in communication with the two poles of a voltaic battery, becomes red-hot in a portion of its length. If that be twisted round spirally, all the heat is then concentrated in the interior of the convolutions. If a very small crucible be placed within the folds of the wire, the greatest conceivable effects of fusion are produced, even the platinum itself may be melted. The eye can scarcely bear the intensity of the light; the assays of ores of gold and silver, in quantities consisting of

several decigrammes, are effected in two or three minutes, and the combustion of diamond is produced in a few seconds. If, in order to prevent external radiation, the spiral wire be placed in the flame of a spirit lamp, the intensity of the incandescence is increased. The spiral may be put under the bell-glass receiver of an air pump, into which any gas may be introduced, and the fusion by this means be effected in gases, in a manner more satisfactory than chemists have hitherto been able to accomplish.

M. Becquerel has also made a skilful application of the power of electricity in the investigation of the influence of masses in the phenomena depending on affinities (a question that occupied much of the attention of philosophers at the beginning of the present century,) and in measuring the degree of those affinities in different circumstances. "In one combination consisting of two atoms," he observes, "the two atoms are united together by a force called affinity, the nature of which is unknown to us, and which varies in intensity according to the temperature, and to different other physical causes. But if we were enabled by means of some instrument of excessive delicacy to seize hold of each of the atoms, and to withdraw them by a contrary force from their reciprocal attractions, the force employed to effect this separation might be regarded as the measure of the attractive force. In default of this ideal apparatus, we possess in electricity a power capable of doing the same thing. It appears from numerous experiments, with the aid of electrical action, that when two salts united with the same acid are dissolved in water, we possess the means of determining with accuracy the strength of the affinity of the acid for each of the two bases, and of following, step by step, the variation in this degree, of affinity, according to the change in that of the saline bases." Mining Review.

Gilding of Metals by Electro-Chemical Action.

M. de la Rive has succeeded in gilding metals by means of this powerful action; his method is as follows:—He pours a solution of chloride of gold (obtained by dissolving gold in a mixture of nitric and muriatic acid), as neutral as possible, and very dilute, into a cylindrical bag made of bladder; he then plunges the bag into a glass vessel containing very slightly acidulated water; the metal to be gilded is immersed in the solution of gold, and communicates by means of metallic wire with a plate of zinc, which is placed in the acidulated water. The process may be varied, if the operator pleases, by placing the acidulated water and zinc in the bag, and the solution of gold with the metal to be gilded in the glass vessel. In the course of about a minute, the metal may be withdrawn, and wiped with a piece of linen; when rubbed briskly with the cloth, it will be found to be slightly gilded. After two or three similar immersions, the gilding will be sufficiently thick to enable the operator to terminate the process. Ibid.

A Newly Invented Planing Machine.

On visiting the Polytechnic Exhibition, Newcastle, a few days ago, we were much amused at witnessing the operations of what appeared to be a little model of a planing machine on a new plan, and we followed its backward and forward motion with a great deal of interest; when, after a very short space of time, we were not a little surprised at the precision and the quantity of work performed; and we discovered by a brass plate, that, instead

of being merely a model, it was, in fact, a new working planing machine, recently introduced into the mechanical workshop by a Mr. John Roberts, of Manchester. It is so simple in its construction, and so portable in its dimensions, that it may be laid on the vice-bench, and set to work either by a motion from a steam engine or by hand, and so useful that one man with it can do the work of three men at the vice. The principal novelties in the invention are—the tool, which cuts both ways—and the extreme facility with which anything to be planed may be fixed in the machine. It may very appropriately be termed a self-acting mechanic, and does credit to the mechanical talents of the ingenious inventor, Mr. Roberts.—*Port of Tyne Pilot.*

Mech. Mag.

Progress of Civil Engineering.

Resistance of Air to Railway Trains. *By* Dr. Lardner.

[continued from page 283.]

As a second test, the engine and tender were now placed in front of four coaches, so as to form a regular train, and it was allowed to descend the plane in the same manner. The engine and tender was then removed, and replaced by two coaches of equal weight, and the train of six coaches was then allowed to descend the plane in the same way. The result of the experiment is exhibited in the following table:—

	Weight.	Total distance run.	Time of running total distance.	Greatest speed.	Total of descending the Sutton plane. 1.89
	Tons.	Yards.	m. s	m. p. h.	m. s.
Fury, Tender, & four coaches	27.45	5.068	12 9	30.5	4 33
Six coaches	27.45	4.850	10 48	31.	4 28
Difference		.218	1 21		0 5

It is needless to enlarge upon these results. The plain and inevitable inference is, and that inference would be further corroborated by what he had still to explain,—that the form of the front, whether flat or sharp, has no observable effect on the resistance; and that whether the engine and tender be in front, or two carriages of the same weight as the engine and tender, the motion of the train, and the resistance to its motion, will be exactly the same.

The form of a boat, or beak, having been given to some of the engines on the Great Western Railway, apparently with a view to diminish the effect of the atmospheric resistance, Dr. Lardner determined to ascertain how far such a form would produce any practical effect. He accordingly constructed a head or a beak, to place before the first carriage of a train. Two boards were constructed equal in height to the body of the carriage, and being attached to each corner, were united in front at an angle, the vertex of the angle being five feet six inches before the flat front of the carriage, and the base of the angle being six feet six inches, corresponding with the width of the carriage. This apparatus would have the effect of a cut-air. It was first tried with a single coach, which, having it attached in front, was moved

as before down the Sutton plane, and the circumstances of the motion having been observed and recorded, the beak was removed, and the coach again moved down with the flat end exposed to the air. The result was as follows:—

	Weight.	Total distance run.	Time of running total distance.	Greatest speed.	Total of descending the Sutton plane, 1.89.
	Tons.	Yards.	m. s.	m. p. h.	m. s.
Coach with pointed front	5.35	3.975	11 0	24.3	5 35
Coach with flat front	5.35	3.905	11 0	23.7	4 45
Difference		70			0 50

It is evident that no effect whatever was produced by the beak, and, consequently, the flat end of the coach produced none of that resistance which Mr. Brunel ascribed to it. The same experiment was now repeated with a train of eight coaches, down the series of inclined planes at Madeley. The beak being placed upon the first coach, the train was started from the summit of the Madeley plane, falling $\frac{1}{177}$, and it was dismissed down the series of planes already described, the circumstances of its motion being carefully observed. It was then brought back to the top of the Madeley plane, and the beak removed, and was once more dismissed, the circumstances being again observed. The following are the particulars of this experiment:—

	Weight.	Total distance run.	Time of running total distance.	Initial speed.	Uniform speed on 1.177.	Speed at foot of 1.265.	Speed at foot of 1.330.	Time of moving down 1.177.	Time of moving down 1.265.	Time of moving down 1.330.
	Tons.	Yards.	m. s.	m. p. h.	m. p. h.	m. p. h.	m. p. h.	m. s.	m. s.	m. s.
Eight coaches with pointed end foremost	40.75	14.411	26 48	23.70	24.	19.25	14.87	8 41	8 50	4 50
Same train, with flat end foremost	40.75	14.331	25 39	23.37	26.18	19.25	14.35	7 53	9 32	4 57
Difference		80	1 9	.33	2.18		.52	0 48	0 42	0 7

It appears, therefore, that the distance run without the sharp end differed only eighty yards in a distance of about eight miles; and the other differences exhibited in the table, are evidently such only as would take place with the same experiment twice repeated with the same carriages.

With a view to ascertain how far mere magnitude of frontage, independent of the general magnitude of the train, is productive of resistance, the front of a coach was enlarged by side boards, extending on either side about twenty inches, adding about twenty-four square feet to the front surface, forming a sort of wings in front of the carriage, but no corresponding width being given to any other part of the carriage. The coach, thus prepared, was placed at the summit of the Sutton plane, and allowed to descend from

a state of rest. It was then brought once more to the summit, and the sides removed, and it was allowed to descend with its proper front. The result of these two experiments is exhibited in the following table:—

	Weight.	Total distance run.	Time of running total distance.	Greatest speed.	Total of descending the Sutton plane, 1.89.
	Tons.	Yards.	m. s.	m. p. h.	m. s.
Coach with enlarged front	5.35	3,139	9 10	19.15	5 31
Coach with ordinary front	5.35	3,289	9 2	21.45	4 15
Difference		150	0 8	2.30	1 16

From which it was inferred, that mere width of frontage, apart from the general increase of magnitute, was not productive of any considerable practical effect in increasing the resistance.

A strong impression existed in the minds of some engineers and scientific men, to whom Dr. Lardner communicated the results of these experiments while they were in progress, that the shape of the hinder part of the train might have an effect upon the resistance. It was supposed that in very rapid motion a tendency to a vacuum would be produced behind the train, and that a corresponding atmospheric resistance, due to this partial vacuum, would be produced in front; that, consequently, if the square shape was removed from the hinder part, less resistance would be found. Although Dr. Lardner did not attach any weight to this objection, he was willing, nevertheless, to submit it to trial, and with that view he prepared a train of three carriages, which he first placed at the summit of the Sutton plane, falling $\frac{1}{89}$, and allowed them to descend by gravity in their ordinary state. He next allowed them to descend, having the pointed end behind; they next descended with the pointed end before; and, lastly, they were once more allowed to descend without the pointed end. The result of these four experiments is given in the following table:—

	Weight.	Total distance run.	Time of running total distance.	Greatest speed.	Time of moving down Sutton plane 1.89.	Time of moving 2¾ miles.	Time from stake 12 to stake 28.
	Tons.	Yards.	m. s.	m. p. h.	m. s.	m. s.	m. s.
Four coaches, with flat front and end	14.8	5,209	13 50	32.14	4 28	7 54	2 9
Same, with pointed end	14.8	5,350	13 45	31.03	4 25	7 50	2 9
Same, with pointed front	14.8	5,576	13 1	32.14	4 23	7 30	2 5
Same, with flat front and end	14.8	5,518	13 25	32.14	4 22	7 32	2 6

In the third column is expressed the entire distance run, in yards; in the

fourth column is the time of going that distance; in the fifth column is the speed acquired in descending the Sutton plane; in the sixth column the time of descending that plane; in the seventh column the time of moving a distance of 2½ miles from the time of starting; and, in the last column, the time of moving from the twelfth to the twenty-eighth stake, throughout which, the motion being tolerably rapid, the effect of the air might be expected to be greatest. It will be evident, from this table, that the pointed end, whether before or behind, was not attended with any appreciable effect, the discrepancies being only such as would occur in the same experiment twice repeated.

It had been suggested that the resistance opposed by the air might be more or less produced by the spaces between the successive carriages of the train, the end of each successive carriage being more or less exposed to pressure against the air. In order to ascertain what weight this suggestion was entitled to, a train of eight carriages was prepared, having tenter hooks attached round the corners of their ends. Canvas was prepared, which, being hooked on these, might be stretched from carriage to carriage, so as entirely to enclose the space between the successive carriages, and to convert the whole train into one unbroken prism. The train being thus prepared with the canvas, was brought to the summit of the Madeley plane, and allowed to descend towards Crewe, the circumstances of the motion being observed as in the former experiments. It was then again removed to the summit, and, the canvas being taken off, the train was allowed to descend in its ordinary state, the spaces between the carriages being left open. The result of these two experiments is exhibited in the following table; and it will be seen that the differences are nothing more than what would arise from casual causes affecting the same experiment twice repeated:—

	Weight.	Total distance run.	Time of running total distance.	Initial speed.	Uniform speed on 1.177.	Speed at foot of 1.265.	Speed at foot of 1.330.	Time of moving down 1.177.	Time of moving down 1.265.	Time of moving down 1.330.
	Tons.	Yards.	m. s.	m. p. h.	m. p. h.	m. p. h.	m. p. h.	m. s.	m. s.	m. s.
Eight coaches with canvas	40.75	14,367	25 39	26.39	25.57	18.	12.4	8 2	8 47	5 31
Same without canvas	40.75	14,731	25 39	23.37	26.18	19.25	14.35	7 53	8 32	4 57
Difference		364		3.2		1.25	2.31	0 9	0 15	0 34

Being impressed with the idea that the amount of resistance might be more or less dependent on the general volume of air displaced by the train as it moves, rather than by the mere magnitude of frontage, an experiment was made which was attended with a result sufficiently remarkable. A train of five wagons was prepared, weighing exactly 30 tons, and loaded with iron rails: sides and ends were constructed, which, being put up, these wagons received the form of coaches, but which, being movable, could be put up or laid flat upon the wagons at pleasure. This train of wagons was brought to the summit of the Madeley plane, and allowed to descend, by gravity, towards Crewe, the circumstances of its motion being observed, as before. It was then brought back to the summit of the same plane, and the sides were taken down and laid flat upon the wagons, and it was then moved

down the plane. The particulars of these two experiments are exhibited in the following table:—

	Weight.	Frontage.	Total distance run.	Time of running total distance.	Uniform velocity on 1.177.	Velocity at foot of 1.265.	Time of moving down 1.177.	Time of moving down 1.265.
	Tons.	sq.ft.	Yards.	m. s.			m. s.	m. s.
Five wagons, with high sides	30	24.	14,058	34 55	22.75	19.50	18 51	6 55
Same, without high sides	30	47.8	10,019	32 4	17.	8.50	15 44	9 47
Difference		23.8	4,039	2 51	5.75	11.	3 7	2 52

The effect of the form of the wagons upon the resistance is here sufficiently manifest, and the concurrent circumstances upon the several gradients plainly show the increased resistance produced by the increased magnitude of the train. From this and the former experiments, it may therefore be inferred that the mere form, whether of the front or hinder part, or the mere magnitude of frontage, produces no practical effects upon resistance; but that, by increasing not the frontage only, but the *whole volume* of the train, a material effect is produced.

It had been found, contrary to what was at first expected, that by increasing the number of carriages in the train, that portion of the resistance which must be ascribed to the atmosphere was increased. It appeared, at first view, that the chief, if not the only source of atmospheric resistance was to be found in the frontage or maximum transverse section. The experiments, however, are entirely incompatible with any such supposition. Had such been the case, the trains of six and eight carriages ought to have acquired a considerably greater velocity in descending the inclined planes, than the trains of four carriages, which was not the case. This is in some degree accounted for by the result of the last experiment indicating the connexion between the volume of air displaced and the resistance, and not between the mere frontage and the resistance. But, in addition to this, there is another circumstance, which was pointed out by Dr. Lardner long since. The wheels of the several carriges produce a vortex of air around them, and play in some measure the part of fanners or blowers. A considerable force must be absorbed by so great a number of these wheels moving at such a velocity. In a train of eight carriages we have thirty-two three-feet wheels, playing these parts of blowers, and revolving from four to five times in a second. How much force must be expended in maintaining such a motion, it is needless to say. But, besides this, another circumstance was observed. In these experiments, as well as in general railway practice, it is found that an extensive current of air moves beside a train, the current diminishing in velocity as the distance from the train increases. Immediately contiguous to the side of the coaches the air moves with little less velocity than the coaches themselves. Outside that is another current, moving at a less rate, and beyond that another at a further diminished rate. There is, thus, a succession of currents, one outside another, extending to a considerable distance at each side of the train. All the resistance produced by the motion of this mass of air through the atmosphere, forms part of the resistance opposed to the moving power.

In all the experiments which were made on the series of planes between Madeley and Crewe, it was found that in moving over these parts of the line which were curved, the uniform velocity was precisely the same as on those parts which were straight. There was no discoverable difference in the rate of motion, from whence it follows that curves like these, having a radius of a mile, produce no observable effect upon the resistance. The experiments were so numerous, and performed under such a variety of circumstances, that, unexpected as these results were, there can be no doubt of their truth.

It has been stated confidently in print and at public meetings, by men reputed to possess information in practical science, that the atmospheric resistance has been long known, not perhaps with perfect accuracy, but that tables, giving a near approximation, have been published by different eminent men, and are to be found in most elementary works; that calculations, founded on these tables, of the resistance of the atmosphere may be made, and that such calculations would give more correct results than such experiments as have been now described. As such statements are calculated to mislead, Dr. Lardner had no hesitation in declaring that they are utterly unfounded. No details exist, nor have any experiments ever been made by which the resistance of the air to a train of railway carriages could be obtained by any calculation whatever; nor was the amount of such resistance ever suspected, even by the persons who have ventured to utter such statements, as have been here proved to exist.

Having been satisfied of the large amount of the resistance of railway trains at the usual speed of passenger trains, the next inquiry was one of a still more difficult kind, namely, to obtain, by reducing the results of the experiments to mathematical analysis, an estimate of the quantity of this resistance which was due to friction and to the atmosphere respectively. The details of this investigation are not of a nature to introduce into a journal like the *Athenæum*. A part of them, however, may be seen by reference to the volume of the Transactions of the British Association, lately published, and the remainder will appear in Dr. Lardner's second Report. In the meanwhile we may state the results, from which it would appear, that as considerable an error has been committed in overrating the amount of resistance due to friction, as in underrating the whole resistance. The formulæ, established by Dr. Lardner, have been applied to a limited number of experiments performed under different circumstances, and the results agree in giving the friction a value amounting to from five to six pounds a ton, of the gross weight. How widely this differs from the common estimate may be perceived when it is stated, that that estimate is from nine to eleven pounds per ton. Mr. Woods, the engineer of the Liverpool and Manchester railway, has applied a method of calculation to one of M. de Pambour's experiments, by which the resistance from friction is obtained very nearly free from the effect of atmospheric resistance, but it is not the method used by Dr. Lardner. The result obtained by Mr. Woods is the same as that obtained by Dr. Lardner.

Dr. Lardner read at the meeting a communication from M. de Pambour, stating, that that gentleman had been engaged in similar inquiries, as to the amount of the friction and the atmospheric resistance, with a view to correct, in the forthcoming edition of his work on Locomotive Engines, any errors which might have existed in the former edition, and the results which M. de Pambour stated that he obtained from the friction, were the same as those obtained by Dr. Lardner and Mr. Woods.

Dr. Lardner proceeded to say, that the results of this extensive course of experiments corroborated and fully established a doctrine which he had ventured to advance before a committee of the House of Lords in the year 1835, but which was then and subsequently pronounced to be paradoxical, absurd, and one which could have no practical truth. That doctrine was, that a railway laid down with gradients, from sixteen to twenty-five feet a mile, would be, for all practical purposes, nearly, if not altogether, as good as a railway laid down, from terminus to terminus, upon a dead level. The grounds on which he advanced this doctrine were, that a compensating effect would be produced in descending and ascending the gradients, and that a variation of speed in the train would be the whole amount of inconvenience which would ensue; that the time of performing the journey, and the expenditure of power required for it, the expense of maintaining the line of way, and supplying locomotive power, would be the same in both cases; that, therefore, he thought that no considerable capital ought to be expended in obtaining gradients lower than those just mentioned. He stated that he was assailed with the most unsparing ridicule when he advanced this doctrine, and that up to the present hour, so far as he knew, it had never been adopted or assented to by any practical man in the country. He saw, however, its complete verification and establishment in the results of these experiments, and determined on making an *experimentum crucis*, which should put its truth beyond all question. The variety of gradients on the railway extending between Liverpool and Birmingham, offered a favourable theatre for such an experiment, and accordingly a train of twelve coaches was prepared, each coach being loaded to the gross weight of five tons. An engine, called the *Hecla*, was provided, weighing twelve tons, with her tender weighing ten tons, making a gross load of eighty-two tons. It was determined to run this train from Liverpool to Birmingham and back, observing, with the utmost precision, the moment of passing each quarter-mile post, and obtaining thereby the actual speed with which every gradient, from one end to the other of the line, was ascended and descended, and the velocity on the levels. By taking a mean of the speed in ascending and descending the gradients, it would be necessary, if the doctrine held by him had any truth in it, that this mean should be exactly, or very nearly, equal to the speed on a level. The journey was accordingly performed, and the results of it will be published in detail in Dr. Lardner's second Report. But, in the meanwhile, the speed, in ascending and descending the several gradients and the mean between them, is exhibited in the following table:—

Gradient.	Speed.		Mean.
	Ascending.	Descending.	
one in	mile per h.	mile per h.	
177	22.25	41.32	31.78
265	24.87	39.13	32.00
330	25.26	37.07	31.16
400	26.87	36.75	31.81
532	27.35	34.30	30.82
590	27.27	33.16	30.21
650	29.03	32.58	30.80
Level . . .			30.93

He said, that on this table it is scarcely needful to make a single observation. It is quite evident, that the gradients do possess the compensating power which he ascribed to them. The discrepancy existing among the mean values of the speed, is nothing more than what may be ascribed to casual variations in the moving power. This experiment also was made under very favourable circumstances, the day being quite calm. Without going into the details of the principle on which these remarkable results depend, it may be stated generally, that since the chief part of the resistance of a railway train depends on the atmosphere, and is proportional to the square of the velocity, a very small diminution in the velocity itself produces a considerable diminution in its square. A train, in ascending a gradient, may therefore relieve itself from as much atmospheric resistance as is equal to the gravitation of the plane by slackening its speed. If its speed be slackened so as to render the resistance equal to that which it would have upon a level, then the engine would have to work with a less evaporating power than on a level, inasmuch as the motion would be slower. In practice, therefore, it can never be needful to slacken the speed so much as to equalize the resistance with that upon the level. Supposing the evaporating power to remain the same, the speed need only be slackened, so that with the same evaporation an increased resistance can be overcome at a speed less than the level, but not so much less as would render the resistance equal to the level. This, in fact, is what takes place in practice, as is apparent from the results above given.

Dr. Lardner concluded by stating in detail a number of conclusions which he considered to be warranted by the experiments; but he reserved to himself the power, when the experiments should be all reduced, of modifying these conclusions, if it should appear necessary to do so. He stated that many of the experiments had been only recently made, and had consequently not been submitted to mathematical analysis. Meanwhile he had taken care to lay nothing before the Section, except what had been fully borne out by the experiments themselves. He regarded the following conclusions as established by his experiments:—

1. That the resistance to a railway train, other things being the same, depends on the speed.

2. That at the same speed the resistance will be in the ratio of the load, if the carriages remain unaltered.

3. That if the number of carriages be increased the resistance is increased, but not in so great a ratio as the load.

4. That, therefore, the resistance does not, as has been hitherto supposed, bear an invariable ratio to the load, and *ought not to be expressed at so much per ton.*

5. That the amount of the resistance of ordinary loads carried on railways at the ordinary speeds, more especially of passenger trains, is very much greater than engineers have hitherto supposed.

6. That a considerable, but not exactly ascertained proportion of this resistance is due to the air.

7. That the shape of the front or hind part of the train has no observable effect on the resistance.

8. That the spaces between the carriages of the train have no observable effect on the resistance.

9. That the train with the same width of front, suffers increased resistance with the increased bulk or volume of the coaches.

10. That mathematical formulæ, deduced from the supposition that the

resistance of railway trains consists of two parts, one proportional to the load, but independent of the speed, and the other proportional to the square of the speed, have been applied to a limited number of experiments, and have given results in very near accordance, but that the experiments must be farther multiplied and varied before safe, exact, and general conclusions can be drawn.

11. That the amount of resistance being so much greater than has been hitherto supposed, and the resistance produced by curves of a mile radius being inappreciable, railways laid down with gradients of from sixteen to twenty feet a mile have practically but little disadvantage compared with a dead level, and that curves may be safely made with radii less than a mile; but that further experiments must be made to determine a safe minor limit for the radii of such curves, this principle being understood to be limited in its application to railways intended chiefly for rapid traffic.

In the course of his address, Dr. Lardner took occasion to acknowledge the very valuable assistance which he had received from Mr. Edward Woods, the engineer of the Liverpool and Manchester Railway, who assisted Dr. Lardner in almost all the experiments, and conducted some of them himself in Dr. Lardner's absence. To the skill and intelligence of that gentleman, as well as to his general mathematical acquirements, he felt himself much indebted. Mr. H. Earle was also associated in these experiments, and took part in the direction of many of them.

[The preceding report is necessarily much condensed, but may be relied upon as correct in all essential points. The speech of Dr. Lardner took nearly four hours in the delivery.]

Mr. C. Vignolles, C. E., said that he had listened with considerable surprise to the very unexpected results of this elaborate course of experiments; and that having frequently, on former occasions, differed from his friend Dr. Lardner on many material points connected with railway practice, he felt bound to say, on this occasion, that the results which had been attained were most satisfactory, and that they would have a most important bearing on the laying out of railways. It was evident that they would tend to relieve the engineer from the trammels under which he now conceived himself, in most cases, placed, by being compelled to adopt a section at variance with the natural character of the country; that much capital would be saved in future lines, by the engineer not being compelled to incur the same expense as heretofore in excavations and embankments and other works, into the adoption of which he was driven by the supposed advantages of very low gradients. If it be true that gradients of sixteen and twenty feet a mile are practically equivalent to a dead level, it must be equally certain, that gradients of thirty feet a mile, or even more, had not disadvantages, and were not attended with objections, even approaching in importance to those which have been usually assigned to such inclinations. Had these principles been established sooner, much capital would have been saved by shareholders in some lines of railway in process of construction. Mr. Vignolles concluded by expressing the obligation which he was sure the engineering profession would feel to Dr. Lardner and the other gentlemen who carried out these experiments.

Mr. Scott Russell vindicated Dr. Lardner's claim to having been the first to establish the important agency of the atmosphere in resisting railway trains. He stated, that before these investigations were commenced there had been made no public statement, nor had there existed any public document by which any individual was known to have even entered on a similar

investigation; that the experiments which had been made on resistance of the air by Dr. Hutton and others, were altogether inapplicable to such bodies as railway trains moving at such speeds; that Dr. Hutton himself, who had examined the question of the resistance of the air more carefully than those who went before him, admitted, that his own experiments proved nothing except our entire ignorance of either the amount or the law of atmospheric resistance, and that it was only from carefully and well conducted experiments that any such knowledge could be expected; he therefore hoped that these experiments would be the commencement of an inquiry which would terminate in a more enlarged and correct knowledge of atmospheric resistance in general. Athenæum.

Report from Major H. Bache on the Brandywine Light-house.

OFFICE OF THE BRANDYWINE LIGHT-HOUSE,
Philadelphia, November 1, 1839.

SIR: The following report of the Brandywine light-house for the past season, made in compliance with the general regulations of the bureau, is respectfully submitted:

The operations have, in consequence of the failure of Congress to make the additional appropriation called for last session, been limited to such expenditures as could be covered by the balances of former years, and, from the insufficiency of these, were confined to measures preliminary to taking position at the site of the work. Among the most important of these are the building of the caisson, by means of which it is proposed to establish the foundation, and the preparation of the foundation stone. The caisson, with unimportant exceptions, was completed some months since. It is elliptical in form, about fifty feet in length by forty feet in width, and twenty-five feet high, constructed entirely of white oak, thoroughly iron-fastened, and in all respects a substantial vessel, capable, it is believed, of resisting the shock to which it will be exposed, and fully equal in other respects to fulfil the objects for which it was designed. It is still on the stocks, where, protected by a roof from the weather, it will remain until required for use. The stone for the foundation, or the foundation rock, as it may very properly be called, is now preparing under the contract of the 9th of January last. Two courses are finished, and two more are in a state of considerable forwardness, and will, with the remaining courses, be ready before the opening of the coming season of operations. The foundation rock is 42½ feet long by 31½ feet broad, and 20 feet high. It is formed of 671 blocks of rough-hammered stone, disposed in ten courses. Of these blocks, 372 weigh each three tons, and are regular and alike in form; and 299 weigh each from one to three tons, and are irregular and unlike. A single course weighs 161.33 tons, and the entire foundation rock, 1,613.3 tons. Each course, as finished, is laid dry at the quarries, where the necessary platforms and cranes are provided, to prevent the delays in building, arising from errors in working the stone, which might prove fatal to the success of the work. The brick pavement bond is the one adopted for the foundation rock; the joints of each course lying at angles of 45 degrees with those of the courses adjacent, in order to resist, in the most effectual manner, the disposition which the mass, from unequal subsidence or other cause, might have to fall or break off. To give still greater security against this tendency, copper dowels and cramps will be used to bind the whole together. Of the latter, nearly 1,700 will be employed.

The original design for this work contemplated a foundation, built on a mole of breakwater stone from the level of low water. The objections to this mode of construction were stated in a communication addressed to the bureau on the 14th of July, 1837, in which, for reasons then given, it was recommended to establish the foundation by means of a caisson. Further reflection has served to confirm these views. Fears were entertained that, by the plan first proposed, the superstructure, being built upon breakwater stone thrown at random on the bottom, would, by unequal settling, be liable to fracture; and it was doubted whether heavy masses of masonry, raised upon such a base, ever proved entirely satisfactory. It was also urged that, as the masonry, until it reached high-water, would necessarily have to be carried on at short intervals of time, and under very great disadvantages at so exposed a position, the cost of construction would thereby be very much increased. These objections are obviated by the use of the caisson, as the work may be carried on at any stage of the tide, and the masonry built from the bottom, saving the thickness of the caisson, which it is presumed will settle in the sand; thus affording a reasonable expectation that the subsidence will be equal, and the superstructure secured from liability to fracture. It will be remarked that the employment of the caisson does not necessarily constitute a modification of the first design, but rather furnishes a means by which that design may be securely carried out. It would fail, however, to yield all the advantages which belong to such a mode of construction, were the foundation not to receive, under the facilities afforded, a more perfect and stable character. It has, therefore, been deemed proper to substitute for this part of the work masonry of wrought stone, instead of the rubble masonry resting on breakwater stone, as was proposed in the first instance. These changes involve, upon the whole, a considerable increase in the cost of the work; an increase, however, which is fully justified by the additional security afforded of prosecuting the operations to a successful termination, and by the greater stability that will be given to the work itself. This increase, as well as that arising from advance in prices since the date of the first estimate, will be indicated under the proper heads. The most prominent among the latter, is in the cost of breakwater stone, advanced 20 and 11 per cent. respectively for the two sizes, and which is now set down at the contract price of the present season for the Delaware breakwater. It will also be seen that the contingencies have been raised to 17 per cent., as that has been the average, nearly, for several years at the above work, and there is no reason to suppose they would be less for the Brandywine lighthouse.

The following statements will show the increase which the proposed modifications and the advance in prices will cause in the cost of the work:

The original estimate for the space which will now be occupied by the foundation, established by means of the caisson, was as follows:

41 tons of breakwater stone, of pieces of two tons and upward, at $2 50 per ton, ...	$102 50
1,436 tons of breakwater stone, of pieces of ¼ to 2 tons, at $1 80 per ton, ...	2,584 80
340 cubic yards of heavy building stone, at $5 20 per cubic yard, ...	$1,768 00
Laying the same, including all expenses, at $17 20 per cubic yard, ...	5,848 00
	10,303 30

Contingencies, 15 per cent., . . .	1,545 50.
Total amount by original estimate, . .	11,848 80
The revised estimate, by the modified plan, for establishing the foundation by means of a caisson, and under the advance in prices, is as follows: caisson, ...	$11,011 63
962 cubic yards of rough-hammered stone, including lewis-holes and cramp-holes, and channels, at $22 95 per cubic yard, ...	22,077 90
Laying the same, including all expenses, at $8 60 per cubic yard, ...	8,273 20
2,092 copper cramps, at $1 25 each, . . .	2,615 00
	43,977 73
Contingencies, 17 per cent., . . .	7,476 21
Total amount of revised estimate by modified plan, &c., .	51,453 94
Total amount of original estimate. . . .	11,848 80
Total amount of increase, ...	39,605 14

How much of this increase is fairly attributable to the new plan, and how much to the advance in prices and increase for contingencies, it is not easy to determine. If, however, the average prices now paid for breakwater stone be taken as a criterion, more than $8,000 is properly assignable to the latter causes.

The exposed situation of the Brandywine shoal, lying as it does in the widest part of the bay, and within eight miles of the ocean, renders it absolutely necessary that the protecting work be formed at once on bringing the caisson in position; as on the one hand, were the foundation constructed and no protection provided, the action of the waves, in their recoil from the mass, by washing away the sand composing the shoal, would in a very short time undermine and destroy the work; so on the other, were the protecting work completed in the first instance, deposits of unequal density and irregular form would be induced, where now the bottom is singularly hard and flat. The removal of these deposits, and of any stone which from carelessness or design may have been thrown within the same space, would be attended with much labor and no inconsiderable expense, and, what is of much more importance in a work of this character, with a delay which might prove fatal to the undertaking. The two operations, indeed, should be carried on as nearly simultaneously as their very different characters will permit, and, to be secure against the ice and storms of the succeeding winter, be brought to a close in a single season. At so exposed a position as the Brandywine, this may be set down at barely three months, commencing with the 20th of May, a period certainly very limited to complete a work of the extent contemplated, considering the difficulties and vexations under which it must be prosecuted.

The following estimate for the next season is based upon the views just given. Admitting their soundness, the necessity of providing at once ample means to carry them out, need not be urged. The appropriation of a less amount would merely take from the Treasury a sum that could not be applied profitably to this work. It is also proper that the appropriation be available at least two months before the opening of the season, to afford time for making

the necessary contracts and arrangements; otherwise, all operations must be postponed until the following year.

Breakwater, which will form a part of the protecting mole.

11,711 tons of breakwater stone, of pieces of two tons and upward, at $3 per ton, . .	$35,133 00	
21,438 tons of breakwater stone, of pieces of ¼ to two tons, at $2 00 per ton, . .	42,876 00	
Cost of breakwater, . . .		$78,009 00

Foundation to floor of cellar.

Caisson, ...	11,011 63	
775,24 cubic yards of rough-hammered stone, including lewis-holes and cramp-holes, and channels, at $22 95 per cubic pard, . .	17,791 75	
Laying the same, including all expenses, at $8 60 per cubic yard, ...	6,667 06	
1,686 copper cramps at $1 25 each, .	2,107 50	
Cost of foundation to floor of cellar, . .		37,577 94
		115,586 94
Contingencies, 17 per cent., . . .		19,649 78
Total amount, . . .		135,236 72
Amount already appropriated, ...		45,000 00
Additional appropriation required for next season, . .		90,236 72

It is proposed to carry on the operations under the foregoing estimate, in the following manner:

The proper position for the light-house is at the point where a line drawn on the usual sailing course of vessels, proceeding up the bay, bisects the mouth of the channel between the Brandywine and Brown shoals, and strikes the former at the assumed depth. To determine this point, it will be necessary to lay down the lower half of the channel between the Brandywine and Brown, including the seaward points of those shoals, and the western side of the former, with their relation to the meridian and the shore. This operation will consist, in the first instance, in fixing the position of not less than four permanent stations, well selected on the above-named shoals, from which the detailed hydrography, so essential to a correct determination of the point in question, will be carried on. These permanent stations will, each, consist of a single tripod of timber, 35 to 40 feet in height, properly strutted out and weighted at the foot, with a fourth spar rising from the apex, and surmounted by the usual tin cone to ensure its being seen distinctly from the shore. To one or more of these will be attached the tide registers, necessary to a correct reduction of the soundings to any given plane. Of the permanency of these tripods under all circumstances, except against ice and the worm, no doubt is entertained.

The next operation in order is to mark out the site with piles, to guide in placing the caisson and depositing the stone which will surround it. The small number of these piles will allow of their being driven in a few days,

by a pile engine placed on a platform, resting on timber tripods of the kind already described, but smaller in size. To ensure the completion of these operations in proper season, they should be commenced as early in the spring as the boisterous character of the locality will permit.

The placing of the caisson in position is an operation of great delicacy; and on giving, at once, the necessary protection to the bottom around it, depends the success of the work. It is in fact the turning point in the undertaking, and, in comparison with which, the subsequent risks and difficulties are of small moment. No means should, therefore, be neglected to ensure it against failure; and a shortsighted economy would prove fatal to it. These means have been the subject of much anxious reflection, and being predicated on the truth of the proposition that the soil composing the shoal is capable of sustaining the work, are all directed to the single object of retaining this soil in its natural position. In what manner it is proposed to effect this object will now be explained.

The caisson, provided with the necessary moorings and machinery for hoisting stone, having had laid on board as much of the foundation as will cause it to draw about 15 feet water, will be towed by one or more steamboats to some convenient harbour in the immediate neighbourhood of the Brandywine shoal. This point will likewise be the rendezvous for vessels carrying Breakwater stone, and that portion of the foundation coming next in order in the construction. Here the final arrangements will be made, and taking advantage of a settled state of the weather, the whole will move down to the scene of operations. The site, it will be remembered, has already been marked out. It will, also, be borne in mind, that the caisson is supposed to be loaded to a draught of fifteen feet, or 3 feet more than the depth at the proposed site, at the lowest spring tides. It will be evident, therefore, that the caisson cannot be placed in position at less than half tide; and, to allow sufficient time for securing it over the selected spot, this should be done on the flood. At half ebb the caisson will fall on the bottom, when the work of loading it with additional foundation stone will be prosecuted with great diligence, in order to prevent, if possible, its floating again on the rise of the tide. To effect so desirable an object, it will be necessary to take on board about 200 tons in the time that will elapse between half ebb and high water, or about $8\frac{1}{2}$ hours. For this purpose two boom-cranes attached to the caisson, will be employed. These, fully manned, and unloading from separate vessels, will be able, in a favorable state of the weather, to take on board in the time above stated, 85 stones weighing 255 tons; affording a large excess of weight as a set-off against the difficulties and delays incident to so exposed a position, over and above the quantity required to retain the caisson on the bottom at any stage of the tide. The stone thus transferred to the caisson, will be placed conveniently on the decks for being laid by the masons. The eight mooring piles, attached to the caisson will now be driven, by the engine provided for the purpose, in order to prevent any lateral motion to which it may be liable from currents or waves, until the further loading shall make it perfectly secure. If from stress of weather, or other cause, the amount of labour calculated upon above be not accomplished, arrangements will be provided, for flooding the caisson to ensure its safety until such time as the work may be resumed.

The caisson being now secured, the next object is to prevent the sand of the shoal from being carried away by any new action, given by its presence,

to the current or the waves. This will be effected by paving the shoal with breakwater stone. To this end about 75 vessels will be provided, which, estimating their average load at 60 tons, will carry 4,500 tons, a quantity sufficient to cover the bottom to a depth of 3 feet for 60 feet round the caisson: allowing that this space will accommodate ten vessels at the same time, and that two hours would be required to unload a vessel, this quantity may be deposited, in moderate weather, in sixteen hours. The early completion of this measure is deemed so important to the success of the undertaking, that a large force will be employed to prosecute the work as rapidly as possible; and to insure, as far as practicable, a uniform distribution of the stone over the designated space, the place of each vessel and of her deposits will be represented on a diagram. No importance is attached to any minor irregularities which may occur in the paving, as the tides in flowing over the general surface of the stone, so far from removing the sand, will cause deposits in the spaces between the stone. And, again, with a view to compensate for any loss which may have occurred before the paving is completed, a result not anticipated, but principally to prevent the great sill-piece from the attacks of the worm, clean sharp sand will be deposited in large quantities alongside the caisson. The vessels, as they successively deposit their loads, will return to the quarries for more stone to form so much of the final mole as is considered necessary to place the work in a condition of safety against the storms of the approaching winter. This quantity is set down in the estimate at about 33,000 tons, and may be deposited in eleven weeks, or at the rate of 3,000 tons a week, the average quantity frequently received at the Delaware breakwater. The laying of the stone of the foundation rock will be resumed immediately, on the caisson becoming fixed upon the shoal, and the work vigorously prosecuted until completed. As two and a half courses will be laid before proceeding down the bay, but seven and a half of the ten courses will remain to lay after arriving at the shoal. These consist of 500 blocks, and as they will be furnished with lewis and cramp holes, and lettered and numbered, agreeably to diagrams in the hands of the workmen, the hope is entertained that even half the time stated above may be sufficient to finish this part of the work.

In thus laying down a plan of operations, it is not for a moment supposed that it will be expedient, or at all times practicable, to adhere to it. The object is more to elucidate general views in regard to the principles which should govern the mode of proceeding, than to point out the details, which, in a work of so novel a character, must depend upon circumstances which cannot always be anticipated, and must be provided on the spur of the occasion.

It now remains to give a revised estimate for the entire work, under the modifications and increase in prices already noticed. No revision has been made in the plan of the light house proper, or lantern, nor is it probable that any changes in either will be found necessary, that will materially affect the cost of the work. The present object is the successful establishment of the foundation, in which consists the only real difficulty in the construction.

Artificial island, or protecting mole.

14,734 tons of breakwater stone, of pieces of 2 tons and upward, at $3 00 per ton		$44,202 00	
25,037 tons of breakwater stone, of pieces of ½ to 2 tons, at $2 00 per ton . .		50,074 00	
Cost of artificial island, or protecting mole, . . .			$94,276 00

Foundation.

Cost as already stated			$43,977 00

Light-house proper.

The original amount under this head was		21,787 75	
From which subtract (now estimated for in the foundation) the cost of 340 cubic yards of heavy building stone at $5 20 per cubic yard	$1,768 00		
And for laying the same at $17 20 per cubic yard	5,848 00		
Also for laying 148 cubic yards of superstructure, reduced from $17 20 to $8 60 :	1,272 80		
		8,888 80	
Cost of light house proper			12,898 95

Lantern.

Cost, the same as originally estimated			1,340 39
			152,493 07
Contingencies, 17 per cent.			25,923 82
Total amount . . .			178,416 89

It is not improbable that complete security may be given to the structure short of the fulfilment of the profile on which the above estimate is founded, and that the protection given in the first instance may prove amply sufficient, reducing, correspondingly, the aggregate expense. The grounds for this hope may be found in the fact that the proportion of two to one given to the exterior slope of the latter work, is the same, up to the 30th September, 1836, as that of the Delaware breakwater, a work certainly exposed to greater shocks, though, on the other hand, more secure from the greater depth of water in which it is founded. The result may likewise show that the mason's work is set down at too high a rate. Nevertheless, it is deemed safest in a work constructed under such novel circumstances as the Brandywine light-house, to retain both the items at the highest rates, to meet any unforeseen contingencies to which the operation may be liable.

I have the honour to be, sir, very respectfully, your obedient servant,

HARTMAN BACHE,
Major Topographical Engineers, &c.

Col. J. J. ABERT, *Topographical Bureau.*

LUNAR OCCULTATIONS FOR PHILADELPHIA, JANUARY, 1841.					Angles reckoned to the right, or westward, round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜	
Day.	H'r.	Min.	Star's name.	Mag.	From Moon's North point.	From Moon's Vertex.
3	11	22	Im. 7 Tauri,	6	129°	185°
3	12	24	Em.		251	308
9	15	20	Im. A. Leonis,	5	60	76
9	16	33	Em.		226	262
10	15	39	Im. *d* Leonis,	5	101	105
10	16	27	Em.		179	198
24	4	28	Im. 37 Aquarii,	6	90	124
24	5	25	Em		342	23

Meteorological Observations for August, 1840.

Moon.	Days	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rise.	Barometer. 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	69	79	29.90	29.70	E.	Calm.	.40	Rain—flying clouds.
	2	71	79	.90	.90	S.W.	do.		Cloudy—do.
	3	71	80	.84	.90	S.W.	Moderate.	1.30	Cloudy—showery.
	4	68	83	.76	.72	W.	Calm.	.13	Clear—partially cloudy—rain.
☾	5	73	84	.72	.72	W.	do.		Partially cloudy—do. do.
	6	69	80	.72	.65	W.	do.		Partially cloudy—do. do.
	7	70	68	.64	.6[illegible]	W.	do.	.08	Cloudy—showery.
	8	62	79	.66	66	W.	do.		Partially cloudy—clear.
	9	62	78	.88	.92	W.	do.		Clear—flying clouds.
	10	58	79	30.04	30.04	W.	Moderate.		Clear—do.
	11	66	82	.00	29.94	S.W.	do.	.46	Clear—showery.
	12	62	80	29.84	.80	S.W.	do.	1.20	Cloudy—showery.
○	13	70	72	.74	.66	S.W.	do.	2.30	Rain—do.
	14	69	78	.56	.61	W.	do.		Clear—do.
	15	65	80	.82	.88	N.W.	do.		Clear—do.
	16	67	80	30.01	30.07	E.	do.		Cloudy—partially cloudy.
	17	67	79	.08	.21	N.E.	Calm.		Lightly cloudy—do. do.
	18	65	79	.50	.20	E.S.W.	do.		Cloudy—clear.
	19	66	81	.14	05	W.S.W.	do.		Clear—do.
☽	20	66	84	29.96	29.92	W.	do.		Clear—do.
	21	68	86	.90	.88	S.	do.		Clear—do.
	22	71	84	.88	.90	W	do.		Cloudy—clear.
	23	74	87	.85	.80	S.W.	Brisk.	1.20	Lightly cloudy—rain.
	24	67	79	.76	.80	W.	Moderate.		Clear—do.
	25	64	78	.85	.90	N.	do.		Clear—do.
⊗	26	59	70	30.00	30.00	N.S.W.	do.		Clear—do.
	27	63	77	.00	29.95	N.W.	do.		Lightly cloudy—clear.
	28	65	75	29.95	.95	N.E.	do.		Cloudy—do.
	29	67	79	30.00	.97	N.E.	do.		Cloudy—do.
	30	68	80	00	.95	S.	do.		Cloudy—do.
	31	72	81	29.85	.85	S.	do.		Cloudy—do.
	Mean	66.90	79.55	29.89	29.83			7.13	

	Thermometer.		Barometer.	
Maximum height during the month.	87.00	on the 23rd.	30.21	on the 17th.
Minimum " "	58.00	on the 10th.	29.56	" 14th.
Mean	73.22		29.885	

METEOROLOGICAL REPORT

FOR THE STATE OF PENNSYLVANIA,

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

NOVEMBER, 1840.

	County.	Town.	Observer.	Thermometer. 7, A.M.	2, P.M.	9, P.M.	Maximum.	Minimum.	Mean.	Days omitted.	Register. Lowest.	Mean.	Days omitted.	Barome 7, A.M.	2, P.M.	9, P.M.	Maximum.
1	Philadelphia,	Philadelphia,	J. M. Hamilton,	42.70	47.31	45.30	55.00	33.00	45.10	8 2/3	20.00	35.11	8	29.95	29.96	30.01	30.4
2	Montgomery,																
3	Bucks,	Newtown,	L. H. Parsons,	38.76	48.38	40.30	60.50	28.75	42.48	2/3	24.00	35.87		29.95	29.90	29.94	30.3
4	Lehigh,																
5	Northampton,	Easton,	Charles Elliot,														
6	Monroe	Stroudsburg,	A. M. Stokes,	33.03	42.48	42.00	60.00	22.00	39.17	11	....	....		29.45	29.47	29.48	29.75
7	Pike,	Milford,	Ralph Bull,														
8	Wayne,	Honesdale,	W. Richardson,														
9	Susquehanna,	Silver Lake,	E. Rose,	36.50	47.10	40.57	64.00	22.00	41.39		18.00	29.20		28.00	27.98	28.00	28.40
10	Luzerne,	Wilkesbarre,	W. F. Dennis,														
11	Schuylkill,	Port Carbon	P. C. Lyceum,	33.65	50.97	33.03	71.00	24.00	42.55	1/3	22.00	29.80		29.33	29.33	29.35	29.96
12	Berks,	Reading,	C. F. Egelmann,	38.57	45.97	39.50	58.00	26.00	41.35		....	...		29.79	29.79	29.79	30.19
13	Chester,	West Chester,	Wm. W. Jefferies,														
14	Delaware,	Haverford,	Haverford School,	36.40	44.93	40.60	59.00	27.00	40.64		25.00	34.45	1	29.51	29.47	29.49	29.90
15	Lancaster,	Lancaster,	Conservatory of Arts,	37.92	47.79	39.98	62.00	29.00	42.56	1	26.00	34.97		29.43	29.39	29.40	29.83
16	York,																
17	Lebanon,																
18	Dauphin,	Harrisburg,	J. Heisely,	39.90	45.55	42.41	55.00	32.00	42.62	2/3	30.00	37.13		29.71	29.68	29.71	30.07
19	Northumberland,	Northumberland,	Andrew C. Huston,	35.43	46.27	38.70	57.00	26.00	40.13		21.00	30.43		29.40	29.37	29.39	29.77
20	Columbia,	Danville,	C. H. Frick.														
21	Bradford,																
22	Tioga,																
23	Lycoming,																
24	Union,																
25	Mifflin,																
26	Juniata,	Mifflintown,	J. A. Rinkead,	33.22	48.86	35.76	66.00	24.00	39.28	3	....	....		29.46	29.45	29.43	29.84
27	Perry,																
28	Cumberland,	Carlisle,	Prof. W. H. Allen,														
29	Adams,	Gettysburg,	Prof. M. Jacobs,	35.88	47.35	38.51	62.00	25.50	40.58		25.00	33.59		29.34	29.31	29.32	29.69
30	Franklin,																
31	Huntingdon,	Huntingdon,	Prof. Jacob Miller,	33.37	46.52	37.80	64.00	22.00	39.23	1	....	....		29.30	29.28	29.27	29.64
32	Centre,	Bellefonte,	John Harris,	34.11	45.42	36.22	56.00	21.00	38.58	12 1/3	....	....		29.22	29.22	29.28	29.60
33	Potter,																
34	M'Kean,	Smithport,	Richard Chadwick,	29.23	42.80	31.03	64.00	20.00	34.35		19.00	27.40		27.97	27.95	27.95	28.30
35	Clearfield,																
36	Cambria,	Ebensburgh,	Richard Lewis,	29.83	42.09	32.45	76.00	18.00	34.79	2 2/3	17.00	27.57	2	27.79	27.80	27.79	28.13
37	Bedford,	Bedford,	Samuel Brown,	33.73	46.63	37.12	68.00	24.50	39.16		....	....		29.18	29.15	29.16	29.51
38	Somerset,	Somerset,	George Mowry,	32.00	42.57	35.03	58.00	20.00	36.53	2/3	16.00	28.53	1	27.83	27.84	27.83	28.22
39	Indiana,	Indiana,	Richard White,	38.03	45.50	35.30	66.00	20.00	39.61		....	....		28.58	28.56	28.54	28.90
40	Jefferson,	Rose Cottage,	C. C. Gaskell,														
41	Warren,	Warren,	C. S. Brown,	41.33	47.77	46.48	65.00	31.00	45.19		31.00	40.70		28.75	28.74	28.76	29.11
42	Venango,	Franklin,	Wm. Connely,	28.97	44.04	34.96	65.00	13.00	35.99	2	....	....		29.00	29.00	29.00	29.90
43	Armstrong,																
44	Westmoreland,																
45	Fayette,	Uniontown,	J. P. Weethee,	32.95	47.32	36.22	64.00	18.00	38.83		....	....		28.98	28.98	28.94	29.29
46	Green,																
47	Washington,	Cannonsburg,	Prof. A. H. Campbell,														
48	Alleghany,	Pittsburgh,	J. P. Bakewell,	38.60	46.90	42.20	60.00	30.00	42.57	1/3	....	....		29.21	29.19	29.21	29.55
49	Beaver,	Beaver,	James Allison,	33.60	47.22	35.80	64.00	21.00	38.87	1	....	....		29.39	29.35	29.37	29.75
50	Butler,	Butler,	Jacob Mechling,	35.30	44.80	40.20	65.00	21.00	40.30		....	....		28.75	28.73	28.73	29.10
51	Mercer,	West Greenfield,	S. Campbell,														
52	Crawford,	Meadville,	J. Limber,														
53	Erie,	Erie,	Park & Reid,														

meter.					Barometer.							Weather.						
Mean.	Days omitted.	Register. Lowest.	Register. Mean.	Register. Days omitted.	7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum	Mean.	Days omitted.	Clear.	Cloudy.	Days omitted.	Rain.	Snow.	Rain and Snow. / Thunder Showers.	Rain in inches.
45.10	8⅔	20.00	35.11	8	29.95	29.96	30.01	30.49	29.60	29.97	8⅓	16	6	8	6	3	....	1.960
42.48	⅔	24.00	35.87	.	29.95	29.90	29.94	30.33	29.50	29.93	⅔	12⅓	15	2⅔	5	1	....	3.760
39.17	11	....	....	.	29.45	29.47	29.48	29.75	29.20	29.47	10⅓	2⅔	11⅓	16	....	....	....	.....
41.39	.	18.00	29.20	.	28.00	27.98	28.00	28.40	27.47	27.99	.	14⅔	15⅓	.	1	2	1	0.481
42.55	⅓	22.00	29.80	.	29.33	29.33	29.35	29.96	29.00	29.32	⅓	14⅓	15⅓	⅓	4	3	1	3.291
41.35	.	....	...	.	29.79	29.79	29.79	30.19	29.35	29.79	.	11	19	.	3	3	1	2.103
40.64	.	25.00	34.45	1	29.51	29.47	29.49	29.90	29.05	29.49	.	14⅔	15⅓	.	5	2	....	5.307
42.56	1	26.00	34.97	.	29.43	29.39	29.40	29.85	28.91	29.41	1	16	13⅔	⅓	10	....	....	2.095
42.62	⅔	30.00	37.13	.	29.71	29.68	29.71	30.07	29.30	29.70	⅓	.	.	.	5	4	....	2.372
40.13	.	21.00	30.43	.	29.40	29.37	29.39	29.77	28.91	29.39	.	7⅔	22	⅓	5	3	....	2.951
39.28	3	....	....	.	29.46	29.45	29.43	29.84	28.92	29.45	3	10	17	3	3	2	....	2.350
40.58	.	25.00	33.59	.	29.34	29.31	29.32	29.69	28.81	29.32	.	17	13	.	4	1	....	2.185
39.23	1	....	....	.	29.30	29.28	29.27	29.64	28.80	29.28	1	17	13	.	3	4	....	.....
38.58	12⅓	....	....	.	29.22	29.22	29.28	29.60	28.76	29.24	12⅓	6	11⅓	12⅓	....	....	....	.....
34.35	.	19.00	27.40	.	27.97	27.95	27.95	28.30	27.58	27.96	.	8⅓	21⅔	.	4	5	....	2.327
34.79	2⅔	17.00	27.57	2	27.79	27.80	27.79	28.13	27.34	27.79	3⅓	9⅔	15⅓	5	2	3	....	.....
39.16	.	....	....	.	29.18	29.15	29.16	29.51	28.70	29.16	.	11⅔	18⅓	.	....	....	....	.....
36.53	⅔	16.00	28.53	1	27.83	27.84	27.83	28.22	27.40	27.83	⅓	10⅔	18⅔	⅔	3	6	1	1.666
39.61	.	....	....	.	28.58	28.56	28.54	28.90	28.10	28.56	.	11	18⅔	⅓	9	1	....	1.670
45.19	.	31.00	40.70	.	28.75	28.74	28.76	29.11	28.40	28.75	.	10⅔	19⅓	.	3	3	1	3.077
35.99	2	....	....	.	29.00	29.00	29.00	29.90	28.48	29.00	5⅓	8⅓	16⅓	5⅓	4	2	....	2.805
38.83	.	....	....	.	28.98	28.98	28.94	29.29	28.29	28.97	.	15	15	.	5	3	....	4.703
42.57	⅓	....	....	.	29.21	29.19	29.21	29.55	28.74	29.20	.	10⅔	19	⅓	3	2	....	1.256
38.87	1	....	....	.	29.39	29.35	29.37	29.75	28.82	29.37	1	13⅔	15⅓	1	4	1	1	2.410
40.30	.	....	....	.	28.75	28.73	28.73	29.10	28.20	28.74	.	.	.	.	4	4	....	2.102

Rain and Snow. Thunder Showers.	Rain in inches.	Winds.																	Hygrometer.					No. of Report.
		North.	N. N. E.	N. E.	E. N. E.	East.	E. S. E.	S. E.	S. S. E.	South.	S. S. W.	S. W.	W. S. W.	West.	W. N. W.	N. W.	N. N. W.	Calm.	Days omitted.	Dew-point.	Days omitted.	Diff. therm. and dew-point.	Wet Bulb.	Days omitted.	
....	1.960	1⅛	⅛	5	.	⅛	.	1⅓	.	.	⅓	2⅓	⅛	2⅜	⅛	5⅜	1⅛	.	7⅓	....	.	... .	....	.	1290
....	3.760	1⅓	⅓	6⅔	2	.	.	⅔	⅛	⅔	.	5	⅛	1⅓	3⅓	5½	⅓	.	1⅔	....	.	.....	....	.	1288
....	.....	3⅓	.	2⅓	.	4	.	.	.	.	.	⅔	⅓	8	.	2⅓	.	.	9	....	.	.....	....	.	1295
1	0.481	4	.	.	.	.	.	1⅓	.	1	.	6⅔	.	6⅓	1	9⅔	.	.	.	....	.	.....	....	.	1331
1	3.291	1⅓	.	1	.	2	⅛	⅔	.	⅓	.	1⅔	1	6⅔	.	3⅔	⅓	11	⅓	....	.	.....	....	.	1303
1	2.103	2	.	1⅓	.	2	.	1⅓	.	⅓	.	2⅔	.	2	.	18	.	.	.	....	.	.....	....	.	1283
....	5.307	1⅓	2	2	1⅓	.	.	⅓	⅓	.	1⅓	3⅓	4	1	1⅓	6⅔	5	.	⅓	47.25	2	.....	....	.	1297
....	2.095	4	.	2	.	2	.	1⅓	.	⅓	.	3⅓	.	3⅓	.	12	.	.	1	40.83	2	.....	45.69	2	1307
....	2.372	3⅓	.	⅔	.	.	.	2⅓	.	⅓	.	.	.	2⅓	.	20⅓	.	.	⅔	....	.	.....	....	.	1284
....	2.951	4	.	3	.	3⅓	.	3⅓	.	1	.	2	.	7	⅔	4	.	1⅓	.	....	.	.....	48.73	.	1285
....	2.350	⅓	.	⅔	.	.	.	2	.	⅓	.	1⅓	.	2⅓	.	6	.	14	3	....	.	.....	....	.	1286
....	2.185	4⅓	1⅓	⅓	.	⅓	.	.	⅔	1⅓	1	2⅓	⅔	5⅓	3	1⅔	⅓	6⅓	½	31.26	6	.....	40.41	6	1373
....	.....	.	.	.	.	8⅓	.	.	.	.	.	.	.	20⅔	.	.	.	.	1	....	.	.....	....	.	1296
....	.....	⅓	⅓	.	.	1⅓	.	.	.	.	.	1⅓	⅓	3	.	1	.	1⅓	21	....	.	.....	....	.	1309
....	2.327	1	.	.	.	4⅓	.	2⅓	.	.	.	2⅓	.	13	⅓	6⅓	.	.	⅓	....	.	.....	....	.	1301
....	.....	.	.	⅔	⅓	1	.	2⅓	.	⅔	.	⅔	⅓	9	.	.	7	4	3⅓	....	.	.....	....	.	1294
....	.....	⅓	.	.	.	.	.	.	.	3	.	3⅔	.	18	.	5	.	.	.	....	.	.. .	....	.	1287
1	1.666	1⅓	.	⅓	.	⅔	.	2	.	⅔	.	4	⅔	8⅓	⅔	1	⅓	9⅓	⅔	....	.	.....	....	.	1308
....	1.670	⅓	.	.	.	⅓	.	⅔	.	1	.	7⅓	.	8⅔	.	4⅓	.	7⅓	.	....	.	...	....	.	1306
1	5.077	⅔	.	.	.	.	.	2⅔	⅔	⅓	⅓	12⅔	1⅓	⅔	.	13⅓	.	9	.	....	.	.....	....	.	1299
....	2.805	.	.	.	.	.	.	9⅓	.	.	.	13⅓	.	.	.	15⅓	.	.	3⅔	....	.	.....	....	.	1298
....	4.703	⅓	.	⅓	.	.	.	3⅓	.	⅔	.	8⅓	.	7⅓	.	4⅓	.	5	⅓	....	.	.....	....	.	1440
....	1.256	.	.	.	.	3⅓	.	⅓	.	3	.	3⅔	⅓	8⅓	⅔	2	.	8⅓	.	....	.	.....	....	.	1292
1	2.410	.	.	1	⅔	.	.	3	.	⅓	.	5	.	⅓	.	13⅓	.	5	1⅓	....	.	.....	....	.	1378
....	2.102	.	.	⅓	.	7⅔	.	.	.	1⅔	.	8	.	11⅔	.	⅓	.	.	.	....	.	.....	....	.	1293